marconi Instruments

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AM/FM SYNTHESIZED SIGNAL GENERATOR

2018 (Code No. 52018-900F)

80 kHz - 520 MHz

AND

2019 (Code No. 52019-900C)

80 kHz - 1040 MHz

Serial Nos. commencing 118401

AMENDMENT RECORD

The following amendments are incorporated in this manual.

Amendment No.	Date	Applies to Ser. Nos. commencing
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MARCONI INSTRUMENTS LIMITED ST. ALBANS HERTFORDSHIRE ENGLAND.

CONTENTS

PRELIMINARIES

Title page Contents Notes and cautions

CHAPTERS

- 1 General information 2 Installation 3 Operation These chapters are contained in a separate Operating Manual Vol. 1.
- 4 Technical description
- 5 Maintenance
- 6 Replaceable parts
- 7 Servicing diagrams
- 8 Modifications and supplements

HAZARD WARNING SYMBOLS

The following symbols appear on the equipment

Symbol	Type of hazard	Reference in manual
\triangle	Static sensitive device	Page (iv)
MATE TO SECURE THE PARTY OF THE	Component containing beryllia	Page (iv)

Note ...

Each page bears the date of the original issue or the code number and date of the latest amendment (Am. 1, Am. 2 etc.). New or amended material of technical importance introduced by the latest amendment is indicated by triangles positioned thus \(\bigcup \ldots \ldots \) \(\delta \) show the extent of the change. When a chapter is reissued the triangles do not appear. Any changes subsequent to the latest amendment state of the manual are included on inserted sheets coded C1, C2 etc.

SECURITY NOTICE

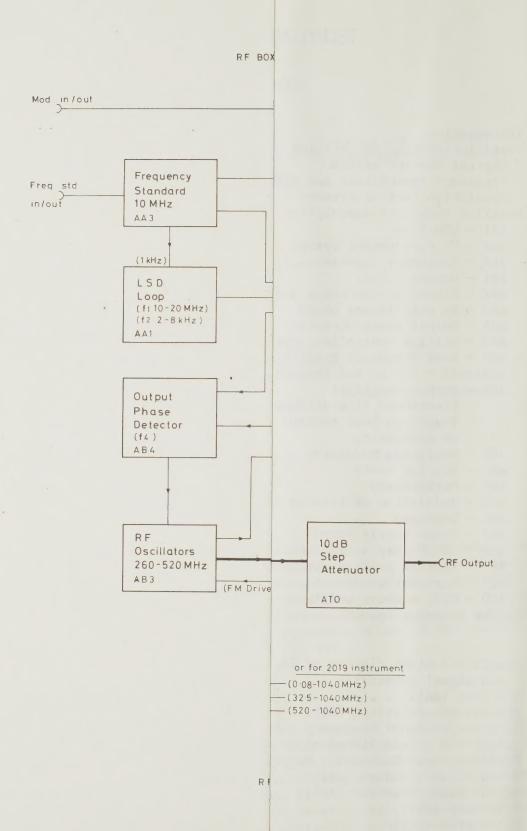
Second functions are grouped into three levels of operation. Access to the first two groups, Normal and First level operation can be freely gained by carrying out the unlocking procedures described in both Operating manual and Service manual. Details for accessing the Second level operation however, are only included in the Service manual. Some user units may wish to further restrict the distribution of this information to selected calibration areas only. To enable this, an alternative Chapter 4, page 37/38a has been included which has the unlocking procedure deleted. Users may then withdraw either page 37/38 or 37/38a as required.

Chapter 4

TECHNICAL DESCRIPTION

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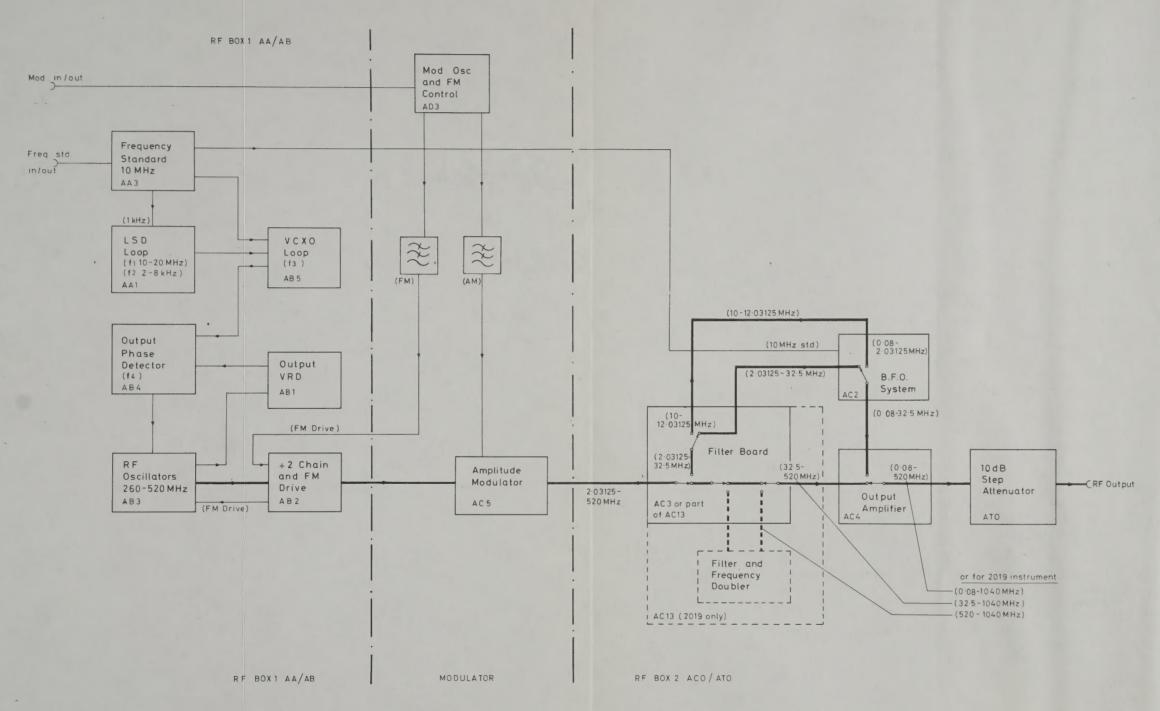


INTRODUCTION

- 1. The 2018 is a 0.08 MHz to 520 MHz synthesized signal generator providing calibrated output levels from 13 dBm to -127 dBm. 2019 is a 0.08 MHz to 1040 MHz synthesized signal generator similar to 2018 except that a frequency doubler circuit enables it to cover frequencies up to 1040 MHz with the same output level range. The output frequency of both 2018 and 2019 is phase locked to a frequency standard and can be set to a resolution of 10 Hz at frequencies up to 520 MHz and to a resolution of 20 Hz above 520 MHz (2019 only).
- 2. Both instruments can be frequency modulated or amplitude modulated from external or internal modulation sources. The internal modulation source provides five fixed modulation frequencies; re-selection of components within the instrument allows alternative frequencies to be set if required.
- 3. Calibrated output levels from -127 dBm to +13 dBm (0.2 μ V to 2 V e.m.f.) in the c.w. and f.m. modes and up to +7 dBm (1 V e.m.f.) in the a.m. mode are provided. A choice of nine output level calibration units can be obtained on the front panel. The r.f. output level can be set to a resolution of 0.1 dB or better over the entire output voltage range and features a total cumulative accuracy of ± 1 dB up to 520 MHz (± 2 dB, 520 MHz 1040 MHz). Protection against the accidental application of up to 50 W of reverse power is provided by a fast responding reed relay.
- 4. Front panel operation is carried out by direct entry of required settings via the keyboard. Microprocessor control ensures maximum flexibility and allows programming by the General Purpose Interface Bus (GPIB). This facility is offered as an optional accessory enabling the instrument to be used both as a manually operated bench instrument or as part of a fully automated test system. Facility is also made for the use of an external standard reference when this is preferred.
- 5. A second function mode of operation includes means of setting the GPIB address, selection of alternative r.f. level calibration units, access to various calibration routines and a facility to aid diagnostic fault finding.

OVERALL TECHNICAL DESCRIPTION

- 6. The 2018/2019 signal generator is divided into three main areas. The first area is the digital control system by which the microprocessor board AA2 receives and sends data to the various p.c.b's in the instrument. This is accomplished by means of an internal instrument bus.
- 7. The second area consists of a frequency synthesizer and the analogue signal conditioning circuits that are controlled by the data bus in order to produce the required output signal.
- 8. The third area is the modulation control system controlling the audio signals used to amplitude modulate (a.m.) or frequency modulate (f.m.) the carrier output.



TPD4494

Fig. 1 Simplified block diagram of 2018/2019 frequency synthesis and signal processing

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Digital control system

Circuit diagram: Chap. 7, Fig. 3

- 9. The internal data bus consists of a total of 17 control lines. The first eight lines DO to D7, are data lines. The data bus is bi-directional e.g. data may be input into the microprocessor via the front panel keyboard or control data can be sent to the data latches from the microprocessor.
- 10. The next four lines AO to A3, are address lines. These are used to control the address of the latch to which the data is to be sent or from which data is being read.
- 11. The following four lines A4 to A7 are data valid lines. A0 to A3 lines are fed to address decoders and with it one of the data valid lines A4, A5, A6 or A7 is connected to each address decoder. Only when this line is activated '0' low is the decoder enabled, and its decoded output then activates the required data latch.
- 12. The last control line A8 is the GPIB interrupt line. This line calls for the microprocessor to service the GPIB module.
- 13. Bus interconnections are shown in Chap. 7, Fig. 5 Servicing diagrams. The microprocessor AA2 serves as the motherboard in the top r.f. box. Some of the data is latched on AA2 in order to minimize the number of interconnections. The addresses of the other latches are also decoded on AA2 to minimize interconnections. The entire 17 line data bus is connected to AD2 motherboard via an r.f. filter box. The filter box ensures that r.f. signals are not conducted down the data bus. From the motherboard the data bus is distributed to the boards outside the top r.f. box. A further connection is made to the lower r.f. box containing AC2, AC3, AC4 and AC5 via a second filter box.

Frequency sunthesizer and signal processing

Circuit diagram : Chap. 7, Fig. 1

14. The frequency synthesizer provides a stable frequency source at the output of AB3 RF oscillators board covering the frequency range 260 MHz to 520 MHz that is phase locked to the internal frequency standard, board AA3 with a resolution of 10 Hz. As an aid to deriving the frequency at any point in the synthesizer the output frequency from AB3 is considered to be of the form

If an output frequency of 512.34567 MHz is selected then m = 5123 and n = 4567 and the output

fo = $\frac{2 \text{ (m-1)}}{200} \left[10^7 + \frac{(10^4 + \text{n})}{\text{m-1}} \right]$

Intermediate frequencies at significant points within the synthesizer are given as f1, f2, f3 and f4 and are shown on the simplified block diagram Chap. 7, Fig. 1. Each frequency can be determined by applying one of the following formulae:

$$f1 = (10^{4} + n) \cdot 10^{3} = 14.567000 \text{ MHz}$$

$$f2 = \frac{(10^{4} + n) \cdot 10^{3}}{m-1} = 2.844006 \text{ MHz}$$

$$f3 = 10^{7} + \frac{(10^{4} + n) \cdot 10^{3}}{m-1} = 10.002844 \text{ MHz}$$

$$f4 = \frac{10^{7} + \frac{(10^{4} + n) \cdot 10^{3}}{m-1}}{200} = 0.05001422 \text{ MHz}$$

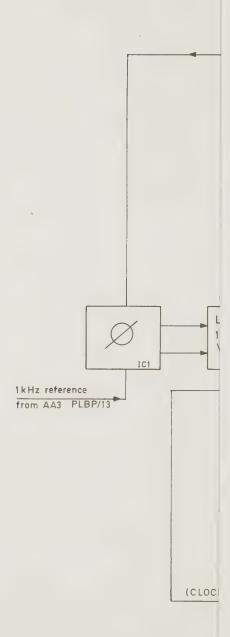
$$f0 = \frac{2 \cdot (5122)}{200} \left[10^{7} + \frac{(10^{4} + 4567) \cdot 10^{3}}{5122} \right] = 512.34567 \text{ MHz}$$

- 15. The least significant digit (1.s.d.) loop, board AAI phase locks an oscillator covering the frequency range 10 to 20 MHz to multiples of 1 kHz. The resulting signal is divided by m-1 in a variable ratio divider (v.r.d.) before being fed to the voltage controlled crystal oscillator (v.c.x.o.) board AB5. Its frequency is then between 2 and 8 kHz.
- 16. VCXO board AB5 then phase locks to the sum frequency of 10 MHz and the 2 to 8 kHz signal from AA1. The resulting 10.002 to 10.008 MHz signal is divided by 100 before being fed to AB4 Output phase detector board. The phase detector on AB4 is used to lock the oscillators on AB3 to the required output frequency. AB3 output is divided by 2(m-1) by a v.r.d. on board AB1. The resulting signal has a frequency of between 50.01 and 50.04 kHz and is fed to AB4.
- 17. If the instrument has not been set to provide f.m. the phase detector system operates at the frequency of 50.01 to 50.04 kHz. However if f.m. is selected, the phase locked loop bandwidth is reduced to avoid the loop removing the required f.m. The frequencies are then divided by 5 before phase comparison and an alternative phase detector and loop filter is used with a lower gain. The resulting signal from AB3 is therefore a 260 to 520 MHz carrier phase locked to the internal frequency standard and is frequency modulated if required. The divide-by-two system on AB2 divides the output from AB3 so that it can provide output frequencies of between 2.03125 MHz and 520 MHz. The output at this point is a nominal square wave.
- 18. The output from AB2 is connected via a semi-rigid cable to AC5 Amplitude modulator in the lower r.f. box. AC5 contains a double balanced mixer that is used as an amplitude modulator. The resulting amplitude modulated signal is then passed on to AC3 or AC13 board. These are different versions of the same board, AC3 Filter board in 2018, or AC13 Filter and frequency doubler board in 2019. If the output signal level from the instrument is required to be greater than +7 dBm then AC5 is set to give its peak envelope power of nominally -5 dBm provided the amplitude modulation is off. The output from AC5 is nominally a square wave.

- 19. The signal into AC3/AC13 is divided into two main paths. Frequencies of 2.03125 MHz to 32.5 MHz are routed via a buffer amplifier to a bank of filters operating in a 200 Ω characteristic impedance system. The filters convert the square wave into a sinusoidal signal. In order to generate a 0.08 to 2.03125 MHz band a 10 MHz to 12.03125 MHz signal is routed to AC2 BFO system where the signal is mixed with 10 MHz from the internal frequency standard and filtered to produce an 80 kHz to 2.03125 MHz sine wave. Frequencies below 80 kHz may be selected but the accuracy of the r.f. level output will be impaired.
- 20. The output from AC2 is a nominal 40 mV, 80 kHz to 32.5 MHz sine wave operating in a 200 Ω system. This signal is fed to AC4 Output amplifier board where it is amplified by a variable gain amplifier, the gain of which is controlled by two j.f.e.t's used as voltage controlled variable resistors. The output from the variable gain amplifier is connected to the output stage amplifier where the output signal level is detected by an r.f. detector. The resulting d.c. signal is compared to a variable reference voltage by a comparator. The comparator output controls the gain of the j.f.e.t. variable amplifier so as to obtain the correct output level from AC4.
- 21. The 32.5 MHz to 520 MHz signal on AC3/AC13 is switched to an amplifier and a 520 MHz low-pass filter. If the instrument is a 2019 the signal can then be switched to a frequency doubler and filter system to generate a 520 to 1040 MHz signal.
- 22. In both 2018 and 2019 the signal from the 520 MHz low-pass filter goes through a filter bank to produce a sinusoidal output signal which is then fed to AC4 output amplifier.
- 23. The 32.5 to 520 MHz (or 1040 MHz for 2019) signal is amplified by a pin diode controlled variable gain amplifier and is then connected to the output stage. The output level from AC4 is controlled by an a.l.c. system consisting of an r.f. detector, comparator and two variable gain amplifiers (j.f.e.t. and pin diode controlled). The level is normally varied over the range +7 dBm to -3 dBm by controlling the reference voltage to the a.l.c. If levels greater than +7 dBm are requested and the a.m. is off the level is increased up to a maximum of +13 dBm. The reference voltage to the a.l.c. is also varied to compensate for the insertion loss of the attenuator, cables and connectors that connect the output signal to the front panel.
- 24. The attenuator provides electro-mechanical attenuation of the output signal from AC4. Provision is made to attenuate the output signal in 10 dB increments from 0 dB to 120 dB. The attenuator output is connected to a reverse power protection system (RPP) which protects the attenuator pads from the accidental application of reverse power. The RPP uses a coaxial reed relay to open circuit the output of the signal generator and can be reset from the front panel or by the GPIB.

Modulation control system

- 25. The internal modulation oscillator is a Wien bridge type and can be programmed to provide one of five fixed frequencies. These can be altered by the user simply by changing two resistor values for each frequency. If internal modulation is selected the modulation oscillator is connected to the MOD INPUT/OUTPUT socket on the front panel. If external modulation has been selected the modulation oscillator is disconnected from the front panel and the external source is connected directly to the two attenuators shown on the simplified block diagram Chap. 7, Fig. 1.
- 26. The audio a.l.c. uses a j.f.e.t. controlled attenuator to produce a fixed output audio voltage provided that the input audio voltage is between 0.8 V and 1.2 V r.m.s. If external modulation is selected the audio a.l.c. may be switched on or off by the front panel MOD ALC key. If internal modulation is in use audio a.l.c. is always switched on.
- 27. The a.m. signal is amplified on AD3 board and routed via the motherboard AD2 to the filter box on the lower r.f. box and then to AC5 Amplitude modulator. An 8 bit digital to analogue (D-A) converter is used to control the audio level according to the required modulation depth.
- 28. The f.m. signal is connected to an 8-bit D-A which controls the signal level in accordance with the f.m. tracking data. This data is stored in the microprocessor board AA2 EAROM store. The f.m. tracking data is stored at 84 frequencies across the fundamental octave band of the instrument (260 to 520 MHz). The microprocessor provides a straight line interpolation between these carrier frequency points and sends the resulting data to the 8-bit D-A.
- 29. The signal is then processed by a 10-bit D-A, this controls the signal level in accordance with the required f.m. deviation. The 10-bit D-A also takes account of the scaling factors introduced by following D-A's and the frequency division of the carrier by the r.f. signal conditioning circuit.
- 30. The f.m. drive signal is attenuated by an 8-bit D-A which divides the audio signal level by successive factors of two. This effectively sets the f.m. range. The signal is then fed to a filter box on the upper r.f. box, and from there to AB2 Divide-by-two chain and f.m. drive board. This board provides further variable division of the signal level by factors of four using reed relay switches to provide further scaling of the f.m. range. The output of AB2 is then connected to AB3 RF oscillators to frequency modulate the oscillator.



DETAILED TECHNICAL DESCRIPTION (BOARD LEVEL)

(AA1) - LSD loop

- 31. This board contains the circuits which control the four least significant digits (LSD) of the carrier wave output frequency. The board provides the reference input to the phase detector on the voltage controlled crystal oscillator (VCXO) loop AB5. Control data for the LSD loop is brought to four 8-bit latches IC8 to IC11 via the instrument bus.
- 32. The LSD loop consists of a phase locked loop built around a 10-20 MHz voltage controlled oscillator (VCO) whose output is divided by a five decade variable ratio divider (VRD) and then fed to a phase detector where it is phase compared with a 1 kHz reference signal derived from the frequency standard board AA3. The output from the phase detector is filtered and the resulting d.c. signal is used to control the VCO. The control voltage changes the VCO frequency so as to annul any phase error at the phase detector, and establish phase lock. The modulus of the VRD controls the frequency of the VCO.
- 33. After buffering, the VCO signal is fed to each clock input of the five decade counters IC3 to IC7 comprising the VRD. The VRD will count upwards whilst the 8 (QD) and 1 (QA) output of each counter are monitored by a multi-input NAND gate IC16. When all the monitored outputs reach the high state the RESET line will go low 'O'. On the arrival of the next clock pulse, the data held in the latches IC8 and IC9 is loaded into the counters. The data consists of the nines complement of the required division ratio (IC7 is hardwired to load in 8). Because a clock pulse is required for reloading the counter this pulse does not increment the counter. To compensate for this missed pulse the NAND gate IC16 is wired to detect the VRD state 99998 for the end of each count sequence rather than 99999. The VRD is capable of dividing by any integer value between 10000 and 19999.
- 34. The RESET line in the VRD also drives one input of the phase detector, IC1, the other being driven by the 1 kHz reference signal. If the RESET frequency is below 1 kHz, a stream of current pulses will be driven into the loop filter (C1, C2, R1) by transistor TR2, this raises the VCO control voltage causing the RESET frequency to rise towards 1 kHz. Similarly if the RESET frequency is above 1 kHz, a stream of current pulses will be drawn from the loop filter by transistor TR3 to lower the control voltage. When phase coincidence is obtained, equal but opposite pulses by TR2 and TR3 are produced thus maintaining the correct control voltage; these pulses are typically 30 nanoseconds wide.
- 35. Another buffered output from the VCO goes to a four decade VRD (IC12 to IC15) which works in a similar manner to the one described above. The microprocessor ensures that the modulus of this VRD falls between 2599 and 5199, according to the required carrier wave output frequency. The LSD signal output is available at PLBN and has a frequency range of approximately 2 kHz to 8 kHz.

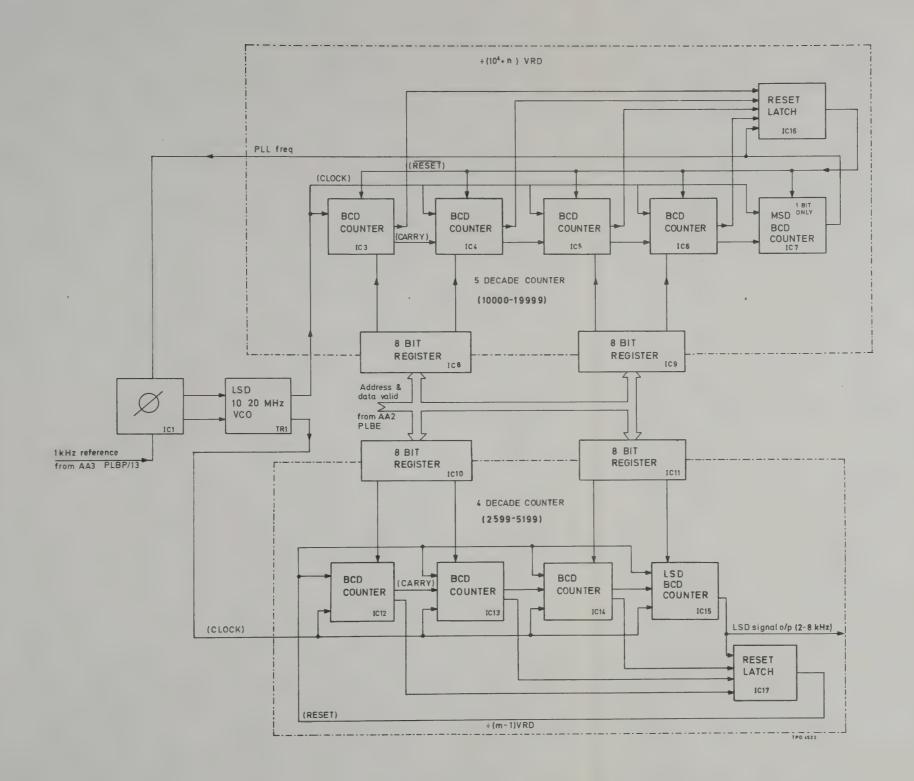


Fig. 2 LSD loop (AA1)

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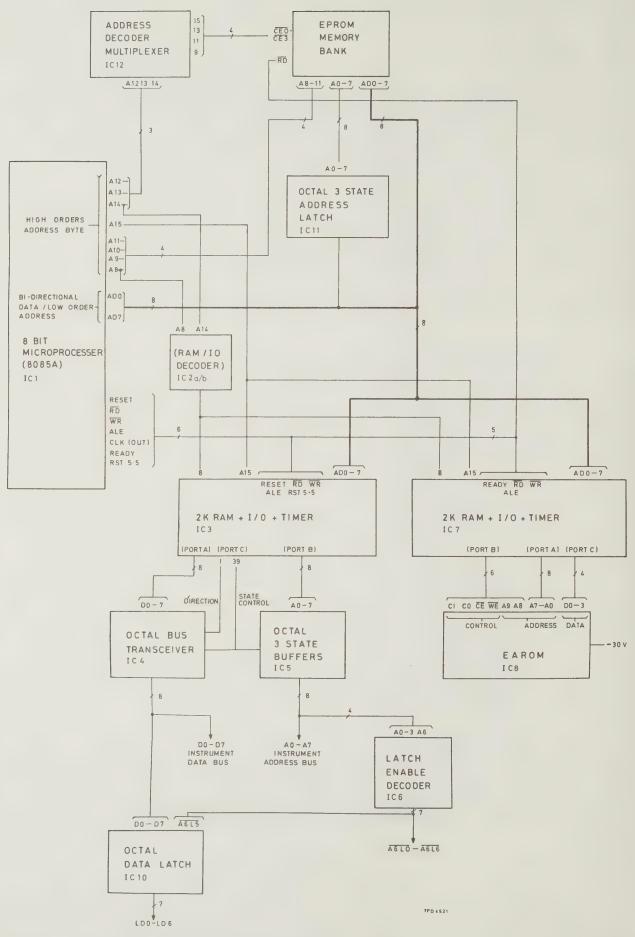


Fig. 3 Microprocessor system (AA2)

(AA2) - Microprocessor system

- 36. The microprocessor board AA2 contains the whole system necessary to drive both address and data bus lines which control the instrument. The 8085A microprocessor IC1 has an 8-bit multiplexed data/low order address bus which is demultiplexed by the latch IC11.
- 37. The program is contained in IC13, 14, 15 and 16, all of which are ultra violet-erasable PROM's. These are enabled by IC12 which decodes A12 and A13 of the address bus, and is itself disabled by A14 high (addresses 4000 to 7FFF hexadecimal). The program space is thus contiguous from address 0000 to 3FFF.
- 38. IC3 and IC7 each contain 256 bytes of RAM (read/write), which is addressed contiguously from address 4000 to 41FF. Port A (pins 21 28) in IC3 carries the instrument's 8-bit bi-directional data bus via a bus transceiver IC4, and Port B (pins 29 36), the instrument's address bus. This is in the form of 4 address lines (bits A0 A3) and uncoded data valid lines (bits A4 A7) giving a total of 64 available latch addresses.
- 39. The mode of operation of the address bus is that the required address is presented to the bus with bits A4 A7 high and the bus is allowed to settle. Then the required data valid line is activated by pulling it low, which either latches the information on the data bus onto the addressed latch (for outputs from the microprocessor) or allows the addressed data source to drive the data bus (for inputs to the microprocessor: either from keyboard or GPIB board). The data valid lines are thus only activated when a valid (and stable) address is present on the other 4 address lines. The direction of the data bus buffer is controlled by a line on Port C of IC3 (pin 39).
- 40. IC6 is the decoder for the first 7 addresses served by data valid line A6 (i.e. it supplies chip enables corresponding to bus addresses A6L0 to A6L6), and IC10 is the A6L5 data latch, used to hold the information which selects which oscillator is in use via AB4, and other signal routeing information on AA3.
- 41. The three ports on IC7 are used to control the data flow in and out of IC8, which is a 4k bit non-volatile read/write memory. Since the memory is arranged as 1k x 4 bit bytes, there are 4 data lines and 10 address lines, so whilst the data bits are on Port C (pins 1, 37-39), the address lines are divided between Port A (pins 21-28), which carries the least significant 8 bits, and Port B (pins 29-34), which carries A8 and A9 in addition to the 4 control lines required to instruct IC8.
- 42. In order to write into or erase IC8, a supply of -30 V must be made available. To avoid accidental corruption of the stored data, this supply is made software switchable (via pin 35 of IC7 Port C), and incorporates protection circuitry to avoid accidental enabling of the supply when switching on and off. The -30 V is generated by a diode-capacitor voltage doubler (D5, D6 and C17) fed from TR5 and TR6, which are in turn driven by an oscillator, part of IC9. This is switched on or off by TR1 and TR7. TR8 and TR9 form a network to detect the failure of the +5 V supply when the instrument is switched off, ensuring that the oscillator is also held off. TR2 and TR3 ensure that whenever the oscillator is stopped, the -30 V supply is pulled up to +5 V: TR4 acts as a buffer to switch off the -30 V output when this pull up occurs.

(AA3) - Frequency standard

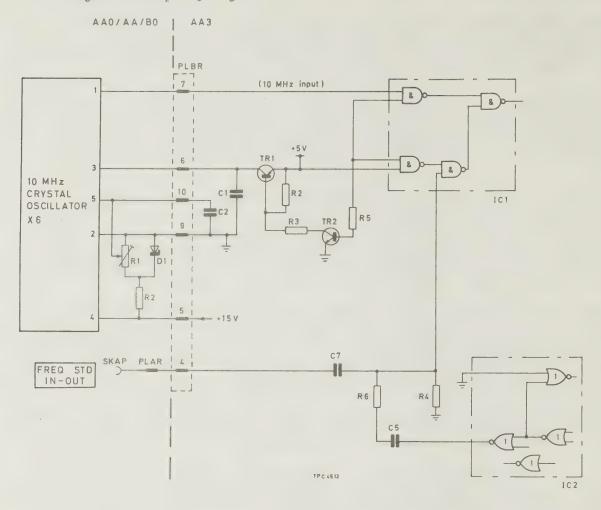


Fig. 4 Internal/external frequency standard (AA3)

- 43. The purpose of board AA3 is to select the required frequency standard and to distribute the necessary reference frequencies derived from the standard throughout the instrument. Control data is brought on two lines from a latch on the microprocessor AA2, via feedthrough capacitors and PLBP pins 5 and 10. If the INT/EXT STD line is high, the voltage supply to the temperature controlled crystal oscillator is turned on and its 10 MHz output frequency appears on PLBR pin 7.
- 44. The potentiometer AAO,RI provides the means of trimming the crystal oscillator frequency. The oven supply is permanently on and is drawn from PLBR, pin 5. The logic gates are enabled so that the 10 MHz signal appears on ICI pin 3. The output of ICI is fed to the VCXO loop, AB5, via TR3, and also to the rear panel via PLBR, pin 4. The output to the VCXO loop is nominally a sine wave, the square wave drive being filtered by the tuned circuit L1 and C9. The 10 MHz standard is also divided down to 1 kHz by ÷100 dividers IC3, IC4 and then routed to the LSD loop via PLBP pin 13.
- 45. If the INT/EXT line is low the internal crystal oscillator is switched off and PLBR, pin 4 is used to input the external frequency standard from the rear panel socket.

46. If the BFO $\overline{\text{ON}}$ line is low another 10 MHz output is taken from IC3 (whichever standard, INT or EXT is in use) and fed via BLBR pin 14. This is used to generate the BFO band of 80 kHz to 2.03125 MHz on AC2. The diode D1 provides isolation when the BFO system is not in use.

ABI - Output v.r.d.

Circuit diagram: Chap. 7, Fig. 9

47. The board ABI contains the high speed variable ratio divider (v.r.d.) which is used in the output phase locked loop to control the four most significant digits of the carrier wave output frequency. The v.r.d. is driven by a signal from the r.f. oscillator board, AB3, and provides the signal for the output phase detector, AB4. Control data for the v.r.d. is fed to two eight bit latches IC4 and IC5 via the instrument bus.

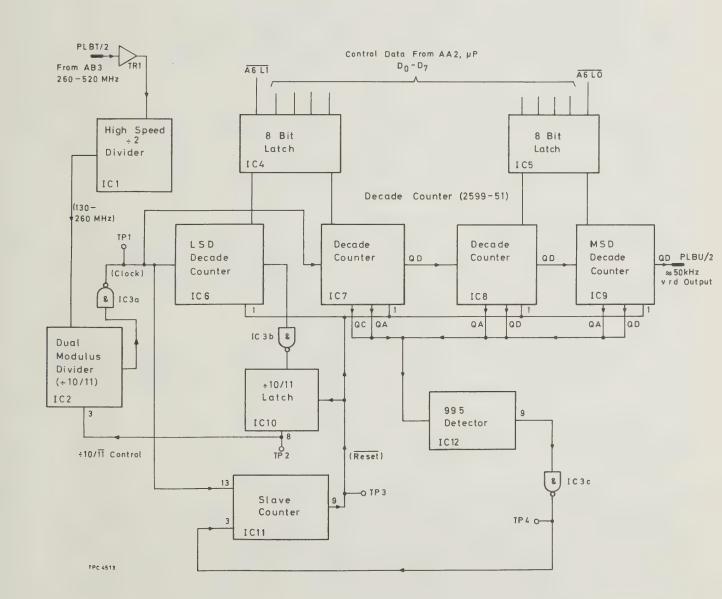


Fig. 5 Output v.r.d. simplified block diagram (AB1)

- 48. The r.f. input signal of approximately -6 dBm is amplified by TR1 and fed to a divide-by-two prescaler, IC1, to produce a frequency between 130 260 MHz at the input to IC2, pin 1. To operate at such a high speed a dual modulus (divide-by-10/11) counter system is used.
- 49. The dual modulus counter, IC2, initially divides by 11 its control line ÷10/II low, when the control line is high its modulus is 10. The state of this control line can change at any time whilst counting, but before the arrival of the eleventh pulse. Thus the time period available for a change of the control line is approximately ten times the input clock period.
- 50. The output from the 10/11 counter drives the clock line, (TP1), for the chain of the presettable decade counters. Each counter is loaded with a nines complement number and counts upward with each pulse (falling edge at each pin no. 8). The two least significant counters, IC6 and IC7 are incremented simultaneously.
- 51. The 10/11 counter IC2 starts in the modulus 11 mode. After every 11 input pulses IC6 and IC7 are both incremented. When IC6 output reaches 9 (1001 in b.c.d.) a low level appears at IC3b, pin 3 causing TP2 to go high to set the 10/11 counter to divide by 10. IC7 is then incremented every 10 input pulses.
- 52. IC8 and IC9 are driven in cascade from IC7. IC6 will continue to count but there will be no further change at TP2 until the RESET pulse occurs. "The early decode" method is used at the end of each v.r.d. sequence in order to reset the decade counters for the next sequence. When the counters IC7, IC8 and IC9 reach the state 995, TP4 is asserted high, and the last four pulses at TP1 are counted by IC11 slave counter.
- 53. The pulse 997 will cause the RESET control line TP3 to be asserted low. This reloads the four decade counters to the nines complement data held in the 8-bit latches IC4 and IC5. Pulse 999 will cause TP3 to assert high once more to enable the counters and also to clock the flip-flop IC10 resetting TP2 low. This reverts IC2, the dual modulus counter to the modulus 11 mode and so the v.r.d. is ready for the next count sequence.
- 54. The microprocessor AA2 ensures that the modulus of the v.r.d. falls between 2599 and 5199 according to the required carrier wave output frequency. The v.r.d. output is taken from the '8' output (QD) of IC9 to PLBU, pin 2 and has a frequency of just over 50 kHz.

AB2 - Divide-by-two chain and f.m. drive

- 55. Board AB2 has two functions, the majority section is used for the divide-by-two chain and a minor section for the f.m. drive. The purpose of the divide-by-two chain is to divide the carrier frequency from AB3 down to the carrier frequency selected by the front panel keyboard or via the GPIB. The input frequency to AB2 is between 260 MHz and 520 MHz. Up to seven divide-by-two elements can be switched in to provide frequency cover from 260 MHz down to 2.01325 MHz.
- 56. If no division of the basic frequency is required (frequencies in the range 260 MHz 520 MHz) the signal is instead routed directly to the output socket SKBX. Frequencies below 2.01325 MHz are derived on a different board, for details see (AC2) BFO system.

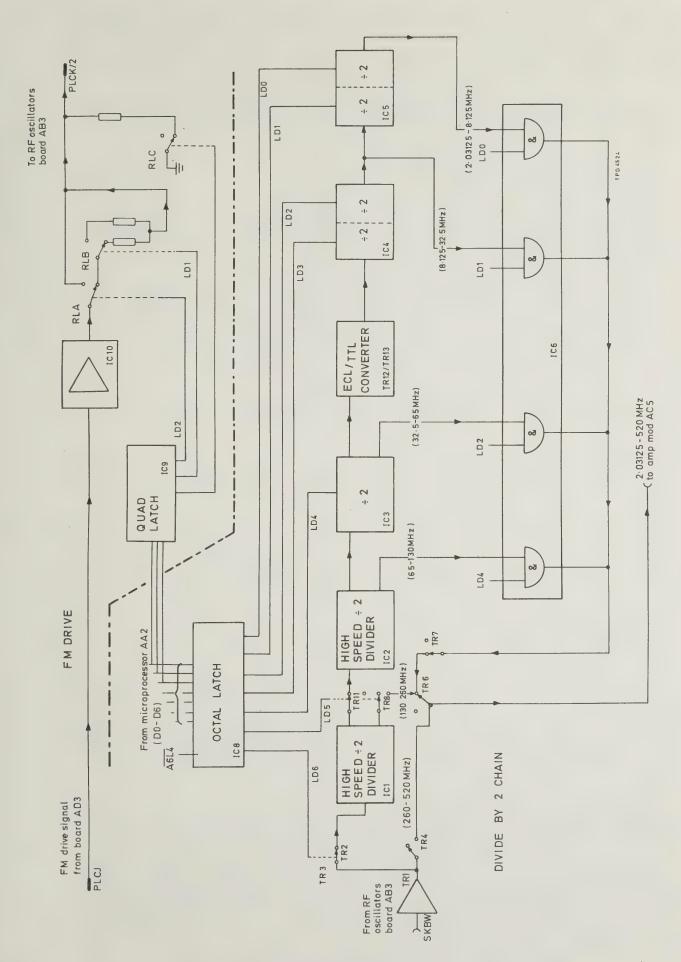


Fig. 6 Divide-by-two chain and f.m. drive (AB2)

- 57. Seven bits of control data from AA2 microprocessor DO D6 are used to control the dividers, these are fed to IC8 octal latch via the instrument bus. Different logic technologies are used to implement the chain of dividers and consequently different methods are used to switch elements in and out.
- 58. The input signal of approximately -6 dBm comes in on SKBW and is amplified by TR1. It is then routed according to the state of latch output LD6 either
 - (1) To the output socket SKBX via TR4, other control lines ensure that TR6 is held off, or
 - (2) The state of LD5 controls the divided signal of IC1 which is either routed through TR8 and TR6 to the output (TR4 and TR7 both held off) or alternatively, used to clock the second divider IC2.
 - (3) Similarly, LD4 determines whether the output from IC2 is routed through IC6, TR7 and TR6 to the output or is used to clock the next divider IC3 and so on. Transistors TR12 and TR13 form an e.c.l. to t.t.l. interface. The two flip-flops in IC4 are driven synchronously with the control lines setting the division to divide-by-two or four as required. IC5 operates in a similar way.
- 59. The divider outputs are gathered together in an e.c.1. wired-OR configuration (IC6, TR7, TR8) so that at the output socket SKBX, all frequencies from 2.03126 520 MHz are available the nominal level being 0 dBm.
- 60. The f.m. drive circuit on AB2 provides the coarse adjustment of the f.m. drive voltage delivered to the r.f. oscillators on AB3. Three bits of control data D0 D2 are used and brought to the quad latch IC9 via the instrument bus. The f.m. drive signal is on PLCJ from where it is fed to IC10 voltage follower which in turn drives a network of switched resistors. These are operated by relays RLA, RLB and RLC. With all the relays energized, maximum f.m. drive signal is applied to the r.f. oscillators AB3, and each relay de-energized decreases the drive by a factor of four.

AB3 - RF oscillators board

- 61. Board AB3 contains the main oscillators for the instrument. Four oscillators each one covering a quarter octave frequency range between 260 MHz and 520 MHz. Only one oscillator is ever turned on at any time and its output frequency is phase locked to the required output frequency by the phase detector AB4. Each oscillator can be frequency modulated by a signal from AB2. The board is contained in a solid aluminium box to reduce microphony to a minimum.
- 62. Each oscillator uses a resonant circuit with a maintaining transistor capacitively coupled to maintain oscillation. The tuning inductor is a printed track which can be adjusted using a sliding link. Varactor diodes are used to voltage tune the oscillator. Chip capacitors are used to tap the transistors TR2, 4, 7, 9, into the tuned circuit. This avoids spurious resonances. Care must be taken when attempting to solder chip components, for details see Chap. 5, Maintenance, Introduction. Each oscillator is designed to have a substantially linear f.m. tracking curve which is instrumental in reducing f.m. distortion and noise.

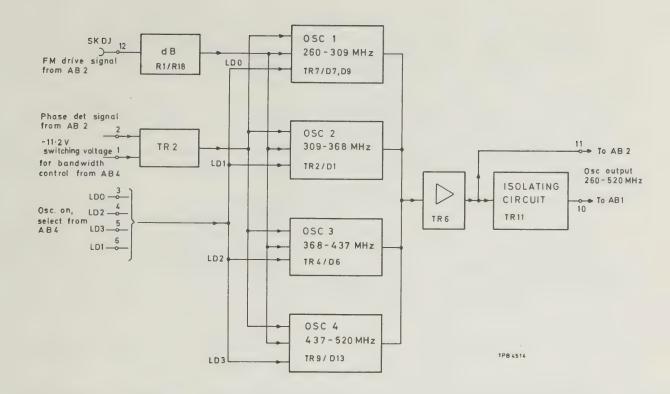


Fig. 7 RF oscillators board (AB3)

- 63. The required oscillator is turned on by connecting tag 3, 4, 5 or 6 to a negative voltage on AB4. This supplies emitter current to the required maintaining transistor. The collector current of the transistor forward biases diodes connected to its collector and therefore connects the r.f. signal to the amplifier TR6. Two outputs from TR6 are taken, one direct via tag 11 to AB2 board for frequency division, the second is via isolating transistor TR11 and tag 10 to the output v.r.d., AB1, to phase lock the carrier frequency. The nominal output from both tag 10 and tag 11 is -6 dBm.
- 64. The oscillators are frequency modulated by a signal appearing on tag 12. This signal is attenuated by R18 and R1 and is then applied to the anode of each varactor diode via r.f. chokes L2, L5, L7 and L11. The main frequency control is achieved by the phase detector signal on tag 2. It is connected to the cathode of each varactor via an R-C network consisting of R2, R3, TR1 and C8. When the f.m. is on the phase locked loop bandwidth is low and TR1 is switched off by connecting tag 1 to -11.2 V on AB4. R2 and C8 then have a long time constant and filter signals appearing on tag 2.
- 65. When the f.m. is off the loop bandwidth is increased in order to reduce the frequency settling time. The j.f.e.t. TRI is then turned on so that the R-C time constant is formed by R3 and C8. This prevents potential feedback instability.

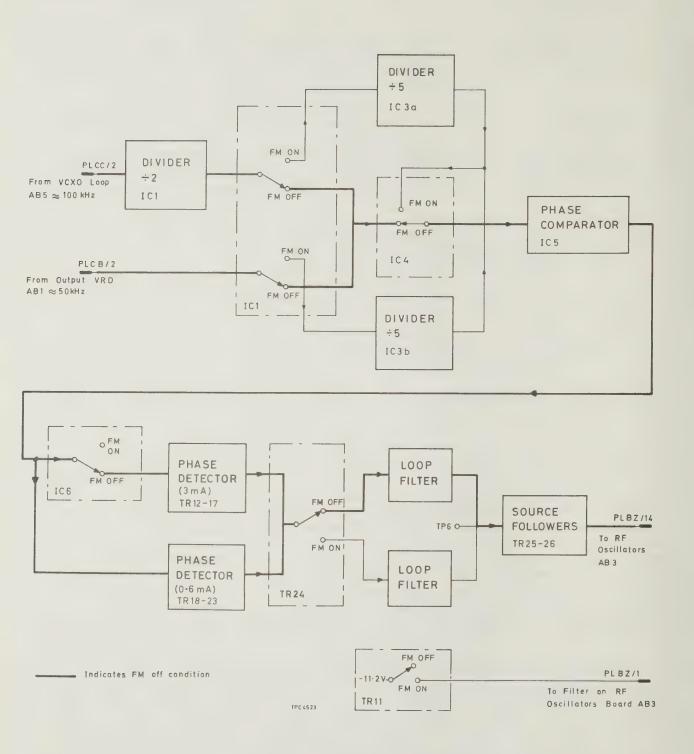


Fig. 8 Output phase detector (AB4)

AB4 - Output phase detector

- 66. Board AB4 contains the phase comparator used to lock the output frequency from AB3 output oscillators to the selected frequency. It also contains voltage regulators to provide low noise power supplies for AB3 and transistor switches TR1 TR4 with IC8, to switch the required AB3 oscillator on.
- 67. The output from AB5 v.c.x.o. loop inputs on PLCC, pin 2. Its frequency is approximately 100 kHz. The frequency is then divided by two in part of IC1. The resulting 50 kHz square wave is then routed to the phase comparator IC5 by one of two routes. If the f.m. is off the phase locked loop bandwidth is high and the 50 kHz signal is routed via IC4 to IC5.
- 68. If the f.m. is on, the loop bandwidth should be lower in order to avoid the loop interfering with the required f.m. This is reduced by several methods. The phase detector current is reduced by a factor of 50 and the loop filter time constants are altered by switching in resistors R41, R42. In addition the phase detector operating frequency is changed from 50 kHz to 10 kHz. When the f.m. is on, the divide-by-five circuit in IC3a is enabled by IC1, pin 5 and its output is routed via IC4 to the phase comparator IC5.
- 69. Similarly the nominal 50 kHz signal from ABI Output v.r.d. is routed to the phase comparator, IC5 via IC4 also, and if the f.m. is on its frequency is divided by five in IC3b before reaching IC5 via IC4.
- 70. In order to minimize any transient frequency change when switching the f.m. on or off the f.m. on/off instruction on PLBY, pin 5 is latched by ICl so that the divide-by-five circuits of IC3 are synchronously enabled.
- 71. Phase comparator, IC5 compares the phase of the signals on pins 3 and 11. If the frequency on pin 3 is higher than that on pin 11, IC5 will produce a string of pulses on pin 6. If the frequency on pin 3 is lower than that on pin 11, IC5 will produce a string of pulses on pin 8. When the signals are phase locked by the loop IC5, pins 6 and 8 are normally low except for a 30 ns pulse.
- 72. Phase detectors, there are two, TR12 to TR17 and TR18 to TR23, these differ only in that the first phase detector operates at 3 mA and the second at 0.06 mA. If the f.m. is off both the phase detectors operate. If the f.m. is on the 3 mA detector (TR12 TR17) is turned off by IC6 and so the gain of the phase locked loop is reduced. Because both phase detectors operate in a similar manner only one is described.
- 73. The signal on IC6, pin 11 is level shifted by TR12 and used to control a differential pair formed by TR14 and TR15. The signal on TP1 switches either TR15 or TR14 on. When TR15 is switched on its base voltage is established by the Zener diode D1 and current flows from R21 into TR15. This current charges up the loop filter formed by C14, R42, R41, TR24 and C13. Similarly TR13 level shifts the waveform on IC6, pin 6, in order to control the differential pair TR16, TR17. When TR17 is on charge is drawn out of the loop filter.

- 74. If the loop looses lock either TR15 or TR17 (assuming f.m. is off) is switched on by the pulses from IC5 and either increases or decreases the charge on the loop filter and hence changes the voltage on TP6 in the direction required to regain phase lock. At phase lock TR15 and TR17 are off except for a nominal 30 ns time interval when both transistors are on. If the f.m. is on TR15 and TR14 are held off and TR21 and TR23 control the loop filter.
- 75. Loop filter time constants, these are switched by TR24 according to whether the f.m. is on or off. When the f.m. is on TR24 is switched on by TR9. This makes the time constants of C14, C13 short to ensure stability in the loop. If the f.m. is off the loop bandwidth is reduced and the time constants of C13, C14 are increased by turning TR24 off. The loop filter is earthed on the box containing AB3 via PLBZ pin 5. This reduces mains hum and phase detector related interference.
- 76. The phase detector output on TP6 is buffered by the source follower TR25, transistor TR26 is a second source follower that ensures the source-drain voltage of TR25 is low in order to minimize gate leakage current (j.f.e.t's suffer leakage due to impact ionization if their drain-source voltage is high). The output from TR25 source is then fed to AB3 via PLBZ pin 14 to control AB3 oscillators.
- 77. The signal on PLBZ, pin 1 controls a filter time constant on AB3 board. When the f.m. is on PLBZ, pin 1 is connected to -11.2 V via TR11. If the f.m. is off, TR11 is switched off and PLBZ, pin 1 is pulled to the same voltage as PLBZ, pin 14 by R49. Note that PLBZ, pin 1 is a high impedance point and can only be monitored by a high impedance probe.
- 78. IC2 and IC7 are voltage regulators that produce -11.2 V and +11.5 V supplies for use on AB3 and AB4. This ensures that the supplies to oscillators are free from hum and noise.
- 79. The required oscillator on AB3 is switched on by the circuits formed by TR1 to TR4 and IC8 as determined by the lines LD0 to LD3 derived from AA2 microprocessor board.

AB5 - Voltage controlled crystal oscillator (VCXO) loop

- 80. The board AB5 phase locks a v.c.x.o. to a frequency equal to the 10 MHz frequency standard plus the output frequency from AA1, LSD loop. The output from AB5 is used as the reference by AB4 output phase detector.
- 81. TR1 is the maintaining transistor for a v.c.x.o. using tuning elements L1, L2, D2, XL1, C3 and C4. The Zener diode D1 provides a regulated +12 V supply to the oscillator. The varactor diode, D2, enables the oscillator to be voltage tuned over the frequency range 10.002 MHz to 10.008 MHz.
- 82. The output signal from TR1 collector is connected to IC1 where the signal is converted to t.t.1. levels. The output from IC1 pin 13 is used to drive IC3 which divides the frequency by 100. The output from IC3, pin 9 is then fed to AB4 via PLCF, pin 2.

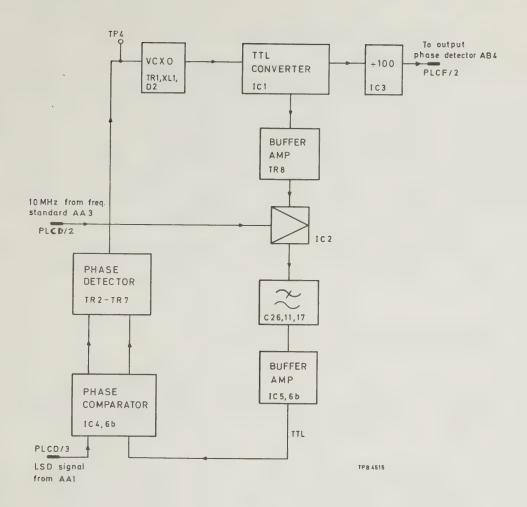


Fig. 9 VCXO loop (AB5)

- 83. The output from IC1, pin 10 is used to drive the phase locked loop to lock the v.c.x.o. to the selected frequency. The output is level shifted and buffered by TR8 and the signal on the collector of TR8 is used to drive a double balanced mixer, IC2. Pin 10 of IC2 is a.c. coupled to ground by C9 so the v.c.x.o. frequency appears across pins 8 and 10, this serves as the local oscillator for the mixer. The linear input for IC2 mixer is developed across pins 1 and 4 and is a 10 MHz sinusoidal signal derived from AA3 frequency standard via PLCD, pin 2.
- 84. IC2 mixes the 10 MHz signal with the v.c.x.o. frequency to produce an audio difference frequency on IC2, pin 6. IC2, pin 12 is also connected to pin 6 via C26, this is an anti-phase component and provides cancellation of the sum product and possible local oscillator breakthrough (at high frequencies) further filtering is provided by C11.
- 85. The resulting signal is then a.c. coupled by C17 in order to produce a signal referenced to ground at IC5, pin 3. R20, R21, C20, C25 provide further filtering of the audio signal. The comparator IC5 converts the audio signal into a nominal t.t.l. compatible square wave at IC5, pin 7. This signal is fed to phase comparator IC4 via IC6a.

- 86. The phase comparator is formed by IC4 and IC6b comparing the phase of the signals on pins 3 and 11. The signal on pin 3 is the output frequency from AA1, LSD loop. If the frequency at pin 11 is higher than that at pin 3 a series of pulses will appear at pin 8. If the frequency at pin 11 is lower than at pin 3 a series of pulses will appear at pin 5.
- 87. The outputs from IC4 drive a phase detector and loop filter to control the v.c.x.o. TR6 and TR7 are level shifting transistors that drive two differential pairs TR3, TR2 and TR4, TR5. The differential pairs inject current pulses into the loop filter formed by C1, R35, C2. If the v.c.x.o. frequency is low TR5 is turned on by the pulses from IC4, pin 5 and the voltage on TP4 will be increased to regain phase lock. Similarly if the v.c.x.o. frequency is high TR2 will be turned on by the pulses on pin 8 and the voltage on TP4 will be decreased to attain phase lock. At phase lock both TR2 and TR5 are normally off except for a short interval of about 30 ns when both transistors are switched on by narrow pulses from IC4.
- 88. IC7 is a voltage follower that buffers the voltage on TP4. The resulting d.c. signal is used to control the varactor diode D2 and hence the frequency of the v.c.x.o.

AC2 - Beat frequency oscillator (BFO) system

- 89. Carrier frequencies below 2.03126 MHz are generated in a b.f.o. on this board by mixing a signal of 10 12.03125 MHz with the 10 MHz standard. The resulting signal is filtered leaving only the difference frequency, which is then fed to the output amplifier AC4.
- 90. The 10 12.03125 MHz signal input at PLCV, pin 1 is buffered by TR2 and applied to the linear port, pin 1 of mixer X1. The 10 MHz signal, from the frequency standard, at PLCU, pin 2 is amplified by TR1 and applied to the local oscillator port, pin 8 of the mixer. The process of mixing produces sum and difference signals at the i.f. port, pins 3, 4. A low-pass filter (2.1 MHz) L1, L2, C5 C8 suppresses the sum component so that TR3 is fed with a signal of 80 kHz 2.03125 MHz. T1 transformer prevents breakthrough of mixer input frequencies (particularly 10 MHz) on the b.f.o. output, and allows the earth plane to be split; this helps to contain the r.f. earth currents. After T1 the signal passes through a second 2.1 MHz low-pass filter, L3, L4, C17 C20, to join a common 1.f. channel output to AC4 via D1, C21 and PLCW, pin 1.
- 91. For b.f.o. operation the d.c. voltage on PLCW, pin 3 is high (controlled from AC3/AC13) so that D2 is off and D1 is on. D2, together with other diodes on AC3/AC13, prevent 10 12.03125 MHz signal breakthrough on the output from AC2. If b.f.o. operation is not required (carrier frequency >2.03125 MHz) PLCW, pin 3 is low, consequently D2 is on and D1 is off. This allows the 1.f. channel input at PLCW, pin 3 to be routed direct to AC4 via PLCW, pin 1. At the same time the 10 MHz and 10 12.03125 MHz signals are turned off.

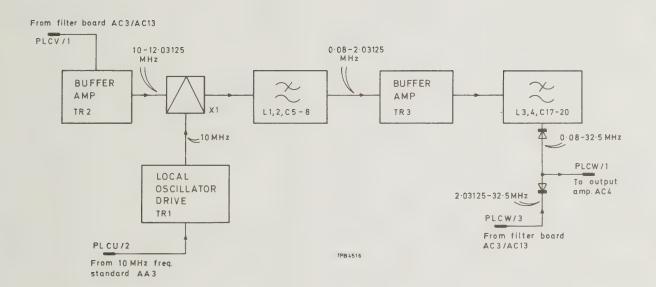


Fig. 10 BFO system (AC2)

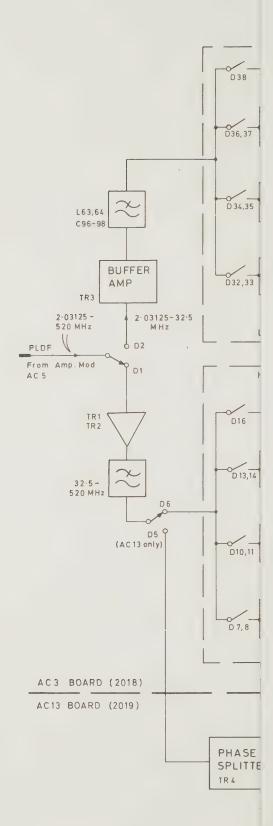


Fig. 1

AC3/AC13 - Filter and frequency doubler board

Circuit diagrams: Chap. 7, Figs. 16 and 19

- 92. The same printed circuit board is used for AC3 and AC13. AC13 is used in 2019 and has both filter and frequency doubler circuits; AC3 is used in 2018 having only the filter circuits (the components for the frequency doubler not fitted). A dashed line in the board legend marks the boundary between the two circuit areas.
- 93. The filter circuits provide harmonic filtering of the r.f. signal from AC5 by means of switched low-pass filters. The frequency doubler circuit doubles the input frequencies 260 520 MHz supplied to it to provide frequency cover for the 2019 up to 1040 MHz. The output signals from AC3/AC13 are fed to the output amplifier, AC4. (Frequencies below 32.5 MHz are fed via AC2).
- 94. AC3/AC13 also performs the bus address decoding for r.f. box 2 ('C' Deck), and the decoded address lines (A7L0 A7L6 from IC1) are routed to their respective latches on AC5, AC4, AC3/AC13. The power supplies for AC5, AC4 and AC2 are distributed from AC3/AC13. The control data for AC3/AC13 is brought to IC2, IC3 and IC6 via the instrument bus.
- 95. Filters. The r.f. signal at PLDF is switched into the h.f. channel (32.5 520 MHz) by D1 if the HF/LF line, IC3, pin 2 is low, or into the 1.f. channel (2.03126 32.5 MHz) by D2 if the line is high. The h.f. channel input is amplified by TR1 and TR2 (+10 dB gain) and then filtered by the 520 MHz low-pass filter L6, L7, C20-C22. If the FREQUENCY DOUBLER IN/OUT line, IC3, pin 12, is high, D6 is turned on and the r.f. signal passes to the main h.f. filter bank.
- 96. If the carrier frequency is between 32.5 and 260 MHz one of the halfoctave low-pass filters in the main h.f. filter bank (L13 L24) will be
 selected according to the data latched on IC2, pins 12, 15, 16, 19 and IC3,
 pin 5. If the frequency is between 260 and 520 MHz the bypass, D16, D17 is
 selected. The main h.f. filter bank output passes through C50.
- 97. For frequencies between 260 and 368 MHz the 368 MHz low-pass filter is switched in by turning on D25,D27 by the 368 and 23 MHz l.p.f's IN/\overline{OUT} 'high' instruction on IC3, pin 6. For all other frequencies this line is 'low' and signals pass through D24,D28. If the frequency doubler is not included D30 is turned on by the FREQUENCY DOUBLER $\overline{IN}/\overline{OUT}$ 'high' instruction, this is inverted by IC5e and the output is then taken from SKCS.
- 98. The h.f. channel operates in a 50 Ω system, but the 1.f. channel operates in a 200 Ω system. The necessary impedance transfer in the 1.f. channel is accomplished by the buffer TR3. LF channel signals from TR3 are first filtered by the 32.5 MHz low-pass filter L63, L64, C96 C98 and then pass to the main 1.f. filter bank. This operates in a similar manner to the h.f. filter bank but uses the data on IC2 pins 2, 5, 6, 9 and IC3, pin 5. The 23 MHz low-pass filter is switched by IC3, pin 6, and the common output routed through C95.
- 99. For carrier frequencies of 2.03126 MHz 32.5 MHz the b.f.o. line, IC3 pin 9, is high, turning D52 on and D51 and D53 off, connecting the output from C95 through to PLCT, pin 2.

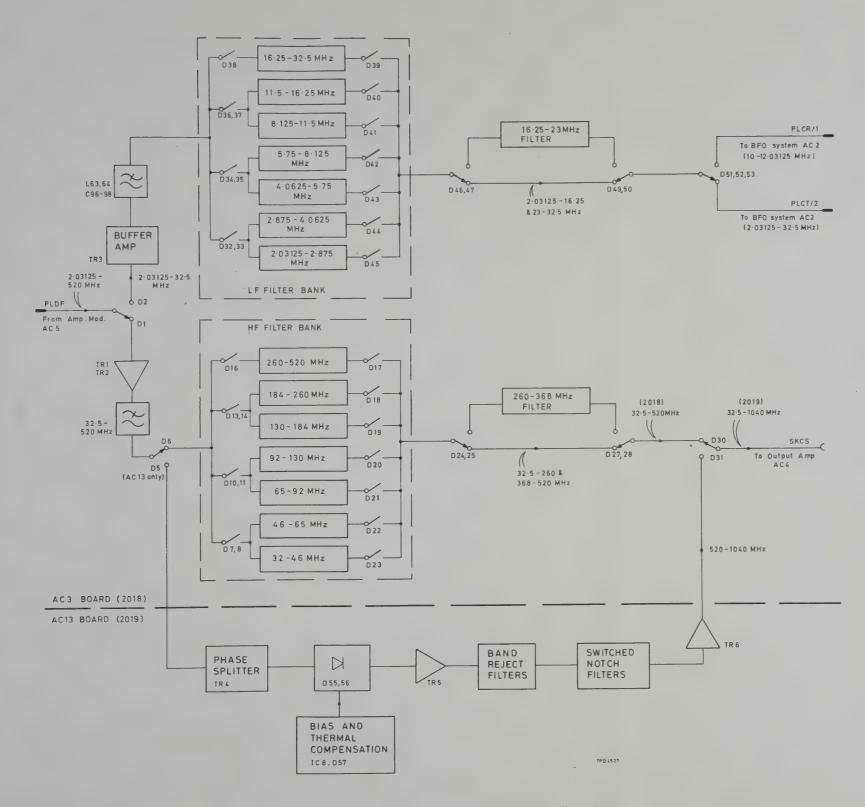


Fig. 11 Filter and frequency doubler board (AC3/AC13)

AC3/AC13 - Filter and frequency doubler board

Circuit diagrams: Chap. 7, Figs. 16 and 19

- 92. The same printed circuit board is used for AC3 and AC13. AC13 is used in 2019 and has both filter and frequency doubler circuits; AC3 is used in 2018 having only the filter circuits (the components for the frequency doubler not fitted). A dashed line in the board legend marks the boundary between the two circuit areas.
- 93. The filter circuits provide harmonic filtering of the r.f. signal from AC5 by means of switched low-pass filters. The frequency doubler circuit doubles the input frequencies 260 520 MHz supplied to it to provide frequency cover for the 2019 up to 1040 MHz. The output signals from AC3/AC13 are fed to the output amplifier, AC4. (Frequencies below 32.5 MHz are fed via AC2).
- 94. AC3/AC13 also performs the bus address decoding for r.f. box 2 ('C' Deck), and the decoded address lines (A7L0 A7L6 from IC1) are routed to their respective latches on AC5, AC4, AC3/AC13. The power supplies for AC5, AC4 and AC2 are distributed from AC3/AC13. The control data for AC3/AC13 is brought to IC2, IC3 and IC6 via the instrument bus.
- 95. Filters. The r.f. signal at PLDF is switched into the h.f. channel (32.5 520 MHz) by D1 if the HF/LF line, IC3, pin 2 is low, or into the 1.f. channel (2.03126 32.5 MHz) by D2 if the line is high. The h.f. channel input is amplified by TR1 and TR2 (+10 dB gain) and then filtered by the 520 MHz low-pass filter L6, L7, C20-C22. If the FREQUENCY DOUBLER TN/OUT line, IC3, pin 12, is high, D6 is turned on and the r.f. signal passes to the main h.f. filter bank.
- 96. If the carrier frequency is between 32.5 and 260 MHz one of the halfoctave low-pass filters in the main h.f. filter bank (L13 L24) will be
 selected according to the data latched on IC2, pins 12, 15, 16, 19 and IC3,
 pin 5. If the frequency is between 260 and 520 MHz the bypass, D16, D17 is
 selected. The main h.f. filter bank output passes through C50.
- 97. For frequencies between 260 and 368 MHz the 368 MHz low-pass filter is switched in by turning on D25,D27 by the 368 and 23 MHz l.p.f's IN/OUT 'high' instruction on IC3, pin 6. For all other frequencies this line is 'low' and signals pass through D24,D28. If the frequency doubler is not included D30 is turned on by the FREQUENCY DOUBLER IN/OUT 'high' instruction, this is inverted by IC5e and the output is then taken from SKCS.
- 98. The h.f. channel operates in a 50 Ω system, but the 1.f. channel operates in a 200 Ω system. The necessary impedance transfer in the 1.f. channel is accomplished by the buffer TR3. LF channel signals from TR3 are first filtered by the 32.5 MHz low-pass filter L63, L64, C96 C98 and then pass to the main 1.f. filter bank. This operates in a similar manner to the h.f. filter bank but uses the data on IC2 pins 2, 5, 6, 9 and IC3, pin 5. The 23 MHz low-pass filter is switched by IC3, pin 6, and the common output routed through C95.
- 99. For carrier frequencies of 2.03126 MHz 32.5 MHz the b.f.o. line, IC3 pin 9, is high, turning D52 on and D51 and D53 off, connecting the output from C95 through to PLCT, pin 2.

100. For carrier frequencies below 2.03126 MHz the b.f.o. line is low turning D51 and D53 on and D52 off. The b.f.o. board, AC2, is supplied with a 10 - 12.03125 MHz signal via PLCR, pin 1 which is mixed on AC2 with the 10 MHz standard to give the required carrier frequency. D53 helps to prevent breakthrough of 1.f. channel frequencies on the b.f.o. output.

101. Frequency doubler (520.00002 MHz - 1040 MHz). The input to phase splitter and frequency doubler is taken from after the 520 MHz low-pass filter. A transistor phase splitter, TR4, feeds the matched pair of diodes D55 and D56 in full wave rectification configuration. A bias supply is derived from a third diode (D57), matched with the other two. This ensures thermal compensation and a sensibly linear output over a wide range of level. Thus a.m. will be virtually unaffected by the doubler. The output from the frequency doubler is then amplified by TR5.

102. The output from the frequency doubler contains both sub-harmonics and harmonics which must be improved by filtering. The filter must reject the sub-harmonic and harmonics while allowing the required frequency to pass with low insertion loss. This is effected by a series of band reject filters. Switching between capacitive elements is carried out with diodes and at two break frequencies, 660 MHz and 820 MHz, in order to give the frequency responses required. Capacitors C119, C120, C123, C124, C135, C136 form switched notch filters that attenuate the sub-harmonic components in the output. The output from the frequency doubler is then amplified by TR6 before being routed to the output connector, SKCS, via the diode switch D31.

AC4 - Output amplifier

Circuit diagram: Chap. 7, Fig. 17

103. This board contains the r.f. output amplifiers, the automatic level control (a.1.c.) circuits, the electronic fine attenuator, and the insertion loss control (i.1.c.). It receives h.f. channel signals from AC3/AC13, 1.f. channel and b.f.o. signals from AC2, and delivers a levelled and calibrated output signal with a 50 Ω source impedance to the coarse attenuator AT0. Control data for the amplifier switching, fine attenuator and i.1.c. is brought to AC4 via the instrument bus.

104. HF channel and a.l.c. This is selected by a 'high' instruction on IC2, pin 5, and a 'low' on IC2, pin 9. TR5 is then turned on and supplies current to the h.f. channel amplifiers, whilst TR16 is off. The h.f. input (frequencies greater than 32.5 MHz) at PLCS is amplified by four r.f. transistor stages. The first two, TR2, TR4, give +6 dB each but the gain can be trimmed at the 1 GHz end by moving R9, R19 along L2, L4 respectively. The last two stages (common with the 1.f. channel) have a combined gain of +10 dB. At high frequencies the gain of TR10 tends to fall; to compensate for this the gain of TR8 is held down at low frequencies but allowed to rise with frequency.

105. High frequency gain can be trimmed by moving R34, R35 along L7. Diodes D8 - D10 protect TR10 from voltage transients. All four stages use active bias networks, TR1, 3, 7 and 9.

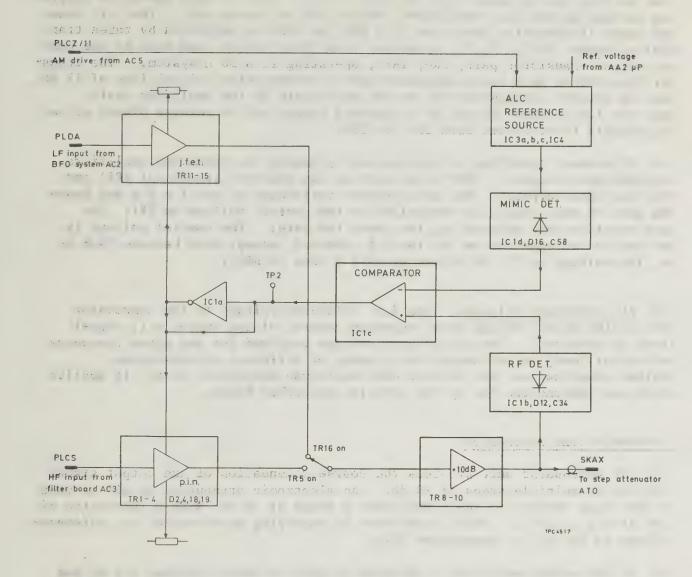


Fig. 12 Output amplifier (AC4)

106. RF level control for the h.f. channel is accomplished using pin diode attenuators in the r.f. amplifier chain. The two fixed-gain stages, TR2 and TR4 are placed between three pin diode attenuator elements, D18-19, D2 and D4. The attenuation produced by these diodes is determined by the control voltage applied to them; the smaller the magnitude of the control voltage, the higher the attenuation. This control voltage is derived by comparing, at the voltage comparator IClc, a d.c. reference voltage from ICld with the r.f. detector voltage from IClb. The voltage from IClc (TP2) controls D2, and the inverted voltage from ICla (TP1) controls D18, D19 and D4. If the r.f. detector voltage differs from the reference voltage, the pin diodes will be driven so as to annul this difference. TR16 is off, and providing D4 is forward biased D5 will also be turned off disconnecting the l.f. channel drive.

107. The r.f. detector measures the peak voltage at the output of the fixed gain transistor pair, TR8, TR10, immediately before the 50 Ω resistor, R47. Thus the voltage can be precisely controlled behind a 50 Ω source impedance. D12, C34 form the negative-peak detector whose voltage is buffered by IC1b. D13 provides temperature compensation for the detector diode. D11, C33 act as a mimic positive-peak detector to help equalize the loading on TR10.

108. LF channel and a.l.c. The l.f. channel is selected by a 'high' instruction on IC2, pin 9, and a 'low' on IC2, pin 5. TR16 is then turned on supplying current to the l.f. amplifiers, whilst TR5 is turned off. The l.f. channel input (frequencies less than 32.5 MHz) at PLDA is amplified by three transistor stages, TR11, 13, 15, operating in a 200 Ω system, and then by the common output transistor pair, TR8, TR10, operating in a 50 Ω system. The transfer from 200 to 50 Ω is accomplished with a consequential signal loss of 12 dB, this is however compensated for by the ample gain in the amplifier chain. When the l.f. channel is on, D5 is forward biased and D4 reverse biased allowing signals to be routed from TR15 to TR8.

109. LF channel levelling is implemented by making the first two amplifiers variable-gain stages. JFET's are used in the emitter circuits of TR11 and TR13 for this purpose. The drain-source resistance of the f.e.t's and hence the gain of each stage, is controlled by the control voltage on TP1; the more negative this voltage is, the lower the gain. The control voltage is derived in the same way as for the h.f. channel, except that because TR16 is on, the voltage on TP1 is offset by -7.5 V (due to R69).

110. ALC reference voltage. The d.c. reference voltage to the comparator IClc is the means through which accurate control of the output r.f. signal level is obtained. The actual d.c. voltage required for any given frequency and output level is influenced by a number of different circumstances. Further complications are present when amplitude modulation (a.m.) is applied which are compensated for by the circuits described below.

Electronic fine attenuator

- 111. ATO attenuator unit provides the coarse attenuation of the output signal from AC4 in multiple steps of 10 dB. An electronic attenuator on AC4 is used to give fine control of the output over a range of 10 dB, with a resolution of 1 mV (r.m.s., p.d.). This is achieved by supplying an accurate d.c. reference voltage to the a.l.c. comparator IC1c.
- 112. In the normal mode AC4 is required to give an output between 158 mV and 500 mV, rising to 1000 mV in the +6 dB mode. For a maximum figure of 1000 and a resolution of 1 a 10 bit binary number is needed i.e. 1000 decimal = 1111101000 binary. This requirement is implemented in IC6, IC3d where IC6 is the 10 bit digital-to-analogue (D/A) converter to which the binary number is sent. The D/A has its own internal data latches.
- 113. The least significant digits are sent first to address A7L2, followed by the 2 most significant digits to A7L3. The number in the D/A determines the gain of IC3d, and hence the output on pin 14 in relation to the input on IC6, pin 3. A change of 1 in the 10-bit number will give rise to a voltage change from IC3d which in turn causes a change in the reference voltage applied to the comparator. When calibrated this will change the output level from AC4 by 1 mV. In calibration the voltage on IC6, pin 3 is set to give a certain r.f. output; R89 is used to calibrate the fine attenuator across its working range. (The purpose of D16, IC1c etc. is explained under a.m. processing.)

Insertion loss control (i.1.c.)

- 114. After the point at which levelling occurs, (TR10 collector) the r.f. signal is subject to the insertion loss of coaxial cables, connectors, ATO coarse attenuator, etc. before the output socket. The insertion loss is frequency dependent, and becomes more pronounced the higher the frequency. To compensate for this AC4 output is increased by an amount equal to the insertion loss at the selected frequency. This is achieved by adding a small offset to the reference voltage applied to the a.l.c. comparator. Clearly the amount of offset needed will increase with frequency.
- 115. This is achieved by IC4 8 bit D/A converter, to which the microprocessor sends a number (address A7L1) representing the correction required. At low frequencies where insertion loss is low, the number sent to the D/A gives IC3b a gain close to -1, and the output on IC3c, pin 8 will have a certain value (depending on the setting of R86). As the frequency is increased the number sent to the D/A reduces the gain towards 0 and consequently the output from IC3c increases in magnitude. This increase in voltage at the input to the fine attenuator is amplified according to the r.f. output level required and fed to the a.l.c. comparator to bring about the insertion loss compensation.
- 116. The number sent out to IC4 is calculated by the microprocessor from data stored in its memory. A sufficiently accurate approximation to the real insertion loss is obtained using just three calibration frequencies 10, 520 and 1040 MHz. At 10 MHz a code number 050 is stored (using Second function 6) and R86 adjusted for the correct r.f. output level. The frequency is then set to 520 MHz and the stored code number increased until the level is again correct. Finally the process is repeated at 1040 MHz (2019 only). When a carrier frequency is selected the microprocessor calculates the required code number from a straight line graph drawn between neighbouring calibration points. The actual binary number sent to the D/A is 255.

AM processing

- 117. The r.f. detector D12, C34 measures the peak voltage of the r.f. signal. When a.m. is present the detector measures the peak of the a.m. envelope; at 100% depth this will be double the voltage at 0% depth. To ensure that the r.f. level is still correct the reference voltage applied to the comparator must be increased by an amount equal to the detector voltage increase due to the a.m. If this is not done there will be an r.f. level error introduced depending on the a.m. depth.
- 118. This is overcome by adding to the d.c. reference processing chain an a.m. drive signal derived from AC5 via PLCZ, pin 11 and including a mimic detector, D16, C58. The mimic detector measures the peak voltage of the a.m. drive signal superimposed on the d.c. reference which when calibrated will produce the correct r.f. output level.
- 119. In practise the r.f. detector has a finite time constant (R45/C34) and so that changes in r.f. level can take place quickly, the time constant must not be too long. Consequently at low modulation frequencies the detector output will decay between envelope peaks at a rate depending on this time constant. In order to preserve the a.m. the reference voltage applied to the comparator must match the r.f. detector voltage exactly. If this is not done the comparator will produce a control signal that will tend to remove the a.m. from the r.f. signal. To make the reference behave in the same way as the r.f. detector voltage the mimic detector is set to have the same time

constant as the r.f. detector by means of the det. trim control R95. Temperature compensation for the mimic detector is provided with D17 (similar to D13).

120. The loop bandwidth of the a.l.c. system is approximately 50 Hz (C47/R74) so at very low modulation frequencies the comparator has appreciable gain and the a.l.c. loop acts as an envelope feedback system. This means there will be a modulation frequency signal on the comparator output which will further modulate the carrier unless the two inputs to the comparator are accurately matched. This is done by applying a calibrated a.m. input of low modulation frequency and adjusting R77, set low mod. freq. until the output from AC4 is correct.

121. For the a.m. to be correct at low modulation frequencies the audio drive level on the reference to the comparator must be exactly equal to the audio level from the r.f. detector. Setting this condition also eliminates the r.f. level error occurring at higher modulation frequencies caused by the uncalibrated peak level of the a.m. drive signal on the reference signal.

AC5 - Amplitude modulator

Circuit diagram: Chap. 7, Fig. 18

122. AC5 board provides amplitude modulation of the output signal from AB2, divide-by-two chain (frequency range 2.03125-520 MHz). The modulated signal is then routed to the Filter board, AC3/AC13. AM depth from 0 to 99% is programmable in 1% steps, using seven bits of control data which are brought to the internal latch in the D/A converter, IC4, via the instrument bus. An eighth bit of data is used to activate the "+6 dB mode", in which the r.f. output level from AC5 is doubled. Under this condition no a.m. is allowed, and the microprocessor instructs 0% a.m. depth.

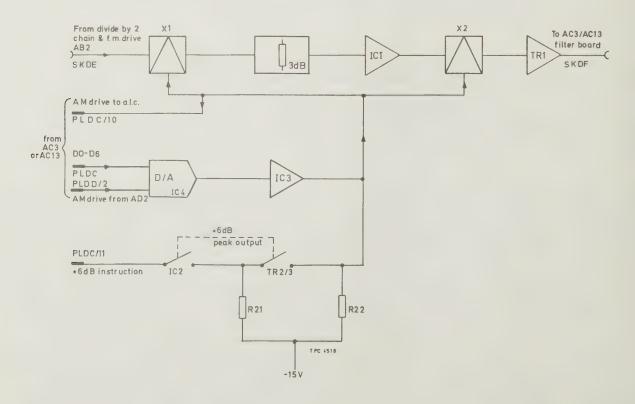


Fig. 13 Amplitude modulator (AC5)

- 123. The modulator consists of two double-balanced mixers, X1 and X2, in cascade, with a 3 dB pad (R2-R4) and a recovery amplifier, IC1, between them. X2 is responsible for the main part of the modulation, with X1 providing a lower level of pre-modulation at large envelope depths. The pre-modulator can be adjusted by varying the a.m. drive signal to X1 using preset R23. The output from X2 is amplified by TR1 and fed to SKDF.
- 124. The audio input is fed to the linear port of the D/A converter, IC4, from PLDD, and is amplified by IC3 whose gain depends on the control data latched into the D/A. The resulting a.m. signal is fed to X1 and X2, and also to the a.l.c. system on AC4 output amplifier via PLDC, pin 10. If the +6 dB mode line is high, TR3 is turned on thus doubling the bias current in X2. This causes an increase in the r.f. output at SKDF of 6 dB.

AD1 - Display board

Circuit diagram: Chap. 7, Figs. 20 and 21

- 125. The display board incorporates the three liquid crystal displays (1.c.d.) that are used to show the current settings of the instrument. The displays are driven using c.m.o.s. logic IC's to apply square waves to the segments of the display. Each l.c.d. has a backplane (b.p.) which is connected to the backplane drive (b.p.d.). The b.p.d. is a 50 Hz square wave.
- 126. The segments are driven by a similar square wave that is either in phase or out of phase with the b.p.d. If the segment drive is in phase with the b.p.d. there is no voltage applied between the segment and the backplane and the segment remains clear. If the segment drive is out of phase with the b.p.d. then a square wave voltage is applied between the segment and the b.p.d. and the segment darkens. It should be noted that d.c. voltages should not be applied to the 1.c.d's since this can result in permanent damage to the display. A nominal -5 V supply for the board is generated using the Zener diode D1.
- 127. The backplane drive is generated by the astable multivibrator IC19. The output from IC19, pin 10 is a 50 Hz square wave switching between 0 V and +5 V. Before being applied to the displays the level of the square wave is translated to be between +5 V and -5 V at the outputs on IC18, pin 3 and IC26, pin 3.
- 128. Information to control the displays enters the board via PLAL. The DO to D7 lines and the A0 to A3 logic levels are made c.m.o.s. compatible by ICl and IC2 open collector buffers and the pull up resistors in R1. ICl3, 15 and 16 decode the address lines to provide control lines to instruct the latches on the board. When the A5 line is held low the output from ICl5, ICl6 corresponding to the address set on A0 A3 lines goes high (+5 V). These output lines, labelled A5LO to A5L12, control which latch latches the data on the D0 to D7 lines.
- 129. With the exception of the decimal point driving system the data lines and the latch control lines are connected to the respective 4056 and 4054 l.c.d. drivers. The 4056 drivers are used to drive the seven segment displays. Each IC latches four input data lines, either D0 to D3 or D4 to D7, and decode the data to drive the seven segment display. The 4056 also level shifts the decoded information and converts it into a square wave between +5 V and -5 V suitable for driving the display. If a binary 15 instruction is latched in the display will remain blank.

- 130. The 4054 display drivers also latch the data line inputs when instructed but these drivers simply convert the input information into a square wave between +5 V and -5 V without decoding the data. This type of drive circuit is used to drive the annunciators on the display where one input line is required to control one amunciator.
- 131. In order to reduce the number of addresses and drivers required the decimal points are driven by a different system. Use is made of the fact that only one decimal point on each display is required to be set at one time. The frequency display decimal point is derived by IC14, 17 and 18. IC17 is a 1 out of 8 decoder which decodes the data lines D0 to D2 and its outputs are latched by IC14, 18. Since only one of the output lines of IC17 can be high one of the decimal points can be set. If the number decoded by IC17 is a binary 7 (i.e. D0 = 1, D1 = 1, D2 = 1) then no decimal point is set since pin 4 of IC17 is not connected. The decimal points for the modulation and r.f. level displays work in a similar manner on D3, D4 and D5, D6 lines respectively.

AD2 - Motherboard

Circuit diagram : Chap. 7. Fig. 22

- 132. The primary purpose of AD2 motherboard is to serve as a means of interconnecting the various areas of the instrument that require access to the microprocessor via the internal instrument bus. The interconnections are generally made by means of plugs on the motherboard that connect to ribbon cable and socket assemblies. The plugs on the board consist of arrays of machine inserted square wire wrap posts arranged in a dual in-line configuration. The p.c.b. AD3 is connected to the motherboard by an edge connector socket SKAH mounted on the motherboard.
- 133. The motherboard also latches the control data for the attenuator. ICl is an octal latch on address A6L10 that latches the data used to control the attenuator pads and the r.p.p. reset. The outputs from ICl are connected to the open collector driver, IC2, to directly drive the solenoids that operate the attenuator pads.
- 134. In order to simplify the interconnections in the lower r.f. box its data valid line, A7, is gated with the A3 line by IC3, thus saving a further line through the filter box. The resulting A3 + A7 output line goes 'low' only when both are held low, i.e., when information is being sent to addresses between A7LO and A7L7.

AD3 - Modulation oscillator and f.m. control

Circuit diagram: Chap. 7, Fig. 23

- 135. Control information for the modulation oscillator and other analogue switches on this board are latched by IC5. The latch addresses are decoded by IC14. The Zener diode D4 generates a -7.5 V supply from the -15 V supply for use by the analogue gates on the board. This enables the analogue gates to be connected to a supply voltage of +5 V and -7.5 V.
- 136. The modulation oscillator is a thermistor stabilized Wien bridge oscillator. ICla is the maintaining amplifier and R2 the thermistor. The frequency of oscillation is determined by the analogue gates IC2, IC3 and IC4 which select from a bank of resistors R3 to R11, C2 and C3 are the two frequency determining capacitors.

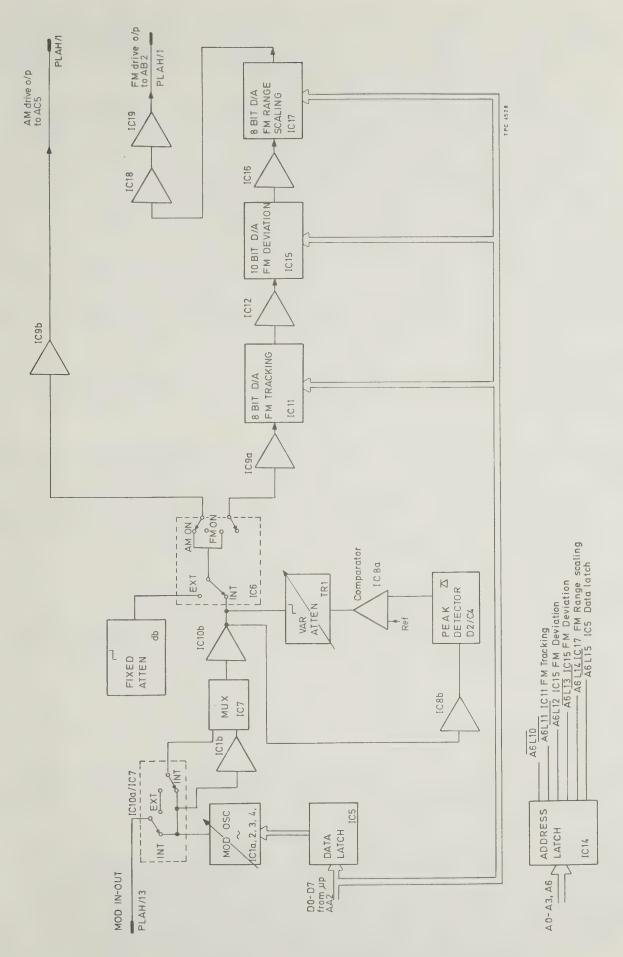


Fig. 14 Modulation oscillator and f.m. control (AD3)

- 137. If internal modulation is selected the output from IC1, pin 1 is routed via IC1b and IC7 to the modulation oscillator output line on PLAH, pin 13. A similar signal is also routed to IC10b. If external modulation is selected the modulation oscillator remains on but the modulation input signal on PLAH, pin 13 is routed to IC10b via IC7 and IC10a.
- 138. The output is then fed to two resistor chains. If external modulation has been selected and the modulation a.l.c. has been set to off, the output from the wiper of R16 is connected to IC6, pin 15. If the modulation a.l.c. has been set to the on condition (this is always so if internal modulation is selected) the signal on IC6, pin 1 is connected to IC6, pin 15. The signal level on pin 1 is controlled by the j.f.e.t. TRI which is used as a voltage variable resistor. TRI is part of an a.l.c. loop which ensures that the signal level on IC6, pin 1 is substantially independent of input level.
- 139. The level on IC6, pin 1 is amplified by IC8b and its level is peak detected by D2 and C4. The resulting d.c. level is compared to a reference level by IC8a and this output is used to control the variable resistor formed by TR1. The reference level on the junction of R23 and R24 is temperature compensated by D1 to offset the temperature coefficient of the detector diode, D2.
- 140. If amplitude modulation is on, the signal on IC6, pin 15 is routed to IC6, pin 14 and then amplified by IC9b. The resulting audio signal is connected to PLAH, pin 11 for routeing to AC5 Amplitude modulator. The variable resistor R30 is used to vary the audio drive level and is used to set the a.m. depth accuracy at 1 kHz modulation frequency.
- 141. If frequency modulation is on the signal is routed to IC6, pin 4 and then amplified by IC9a. The signal at IC9a output is set to a nominal 12 V p-p by R33. The signal is controlled by a series of 3 c.m.o.s. D/A converters. IC11 D/A modifies the drive signal level in accordance with the f.m. tracking data from the microprocessor. IC15 D/A controls the signal level in accordance with the f.m. deviation set and IC17 divides the signal level by factors of 2 in order to provide range scaling.
- 142. The data required by IC15 is a 10 bit binary number and is loaded into the D/A in two bytes. The first byte is the 8 bits corresponding to the least significant bits while the second byte is the 2 most significant bits. The setting of the D/A only changes when the most significant bits are loaded in. The output from IC18 is then amplified by IC19 and the output taken to AB2 via the motherboard AD2 and PLAH, pin 1.

AD4 - Keyboard

Circuit diagram: Chap. 7, Fig. 24

- 143. Keyboard AD4 carries all the front panel key switches, the 1.e.d. indicators for the modulation oscillator frequency and the control logic required to interface the switches and the 1.e.d's to the internal data bus.
- 144. The key switches are arranged as an array organized in rows and columns. The latch IC4 is initially set to give logic 'low' at all its outputs. The pull up resistors in R5 set the logic levels at the inputs to IC5 to a logic 'high'. When the microprocessor is monitoring the keyboard IC5 buffer is enabled to drive the internal data bus and so the microprocessor is able to monitor the state of the keyboard. For convenience the inputs to IC5 are referred to as columns and the outputs from IC4 are referred to as rows.

- 145. When a key is pressed it shorts that column to one of the rows. In order to find which key in a column has been pressed the microprocessor sets all but the top row (connected to IC4, pin 2) to the high state. If the key pressed was in the top row then the column will remain in the 'low' state. If not, the column returns to the 'high' state and the microprocessor sets a 'low' to the next row down (IC4, pin 5) with all other rows set 'high'. This is repeated until the correct row is located. Having determined which row and which column the key was in this uniquely identifies the key pressed.
- 146. The transistors TR1 and TR2 form an electronic extension to the keyboard allowing the microprocessor to identify when the r.p.p. has operated. If the r.p.p. has been tripped TR2 is turned on by the r.p.p. active line and pulls the left-hand column to ground in the same way as the keys do. When the microprocessor scans the keyboard TR1 holds TR2 off when IC4, pin 12 is high and so the keyboard responds in the same way as if a key corresponding to that row and column had been pressed.
- 147. The 1.e.d's in the key switches and the circle of 1.e.d's indicating the modulation oscillator frequency are controlled by the latches IC2 and IC3. The resistors R1 and R2 control the current flowing in the 1.e.d's.

AE1 - Power supply board

Circuit diagram : Chap. 7, Fig. 2

- 148. The mains supply range is set by two selector switches, SAR and SAS, whose position is locked by a cover plate. The mains transformer is located in a steel box underneath board AEI.
- 149. The power supply is required to generate regulated +24 V, +15 V, +5 V and -15 V d.c. voltage lines. The +5 V supply is derived from secondary 1 of the mains transformer. This is rectified by bridge D1 of AMO and is located on the power supply chassis under the board AE1. The rectifier bridges for the other supplies (D1, D2, D3 or AE1) are located on the board AE1 together with the reservoir capacitors C1, C6, C7 and C10.
- 150. The d.c. from the reservoir capacitors is regulated by three terminal adjustable regulators. The regulators for the +5 V and +15 V supplies are ICl and IC2 of AMO and are located on the heatsink on the rear of the instrument. The potentiometers R2, R5, R8 and R11 enable the output voltages of each supply to be adjusted. Each of the regulator's IC's is protected against accidental shorts causing high discharge currents by 1N4004 rectifier diodes. The bypass capacitors C3, C5, C8 and C11 improve the ripple rejection of the regulators. Each regulator also has an internal thermal protection circuit.
- 151. The board AEI has been carefully arranged such that the earth point of the resistor chain at the output of the regulator has been terminated on the chassis by a separate route to that of the reservoir capacitors. This ensures that the outputs from the regulators are free of mains supply ripple.

ATO - 10 dB step attenuator

Circuit diagram: Chap. 7, Fig. 25

152. The p.c.b. AT1 is located in a casting and the board is made of a low loss p.t.f.e. based material. Screens are added to provide signal isolation at high frequencies. The lid of the attenuator uses a compressible foam backed gasket to provide an r.f. seal between attenuator sections.

153. The board ATI provides precision 10 dB steps in the output level and incorporates a reed relay to provide reverse power protection. Each attenuator pad consists of 3 precision chip resistors that provide attenuation of 10 dB, 20 dB or 30 dB. Each pad is switched in or out of circuit by microswitches actuated by a solenoid. When a pad is switched out the r.f. signal is connected to a direct bypass route. The insertion loss of the direct route and the pad (excluding the intended attenuation) is set up to be identical by the adjustment of small flags. These are adjusted by means of nylon screws in the screens. Each pad is separately set up and requires the use of specialist measuring facilities and it is recommended that this is carried out by the nearest Marconi Instruments agent or Marconi Instruments Service Division.

RPP - Reverse power protection

154. Resistors R16 to R20 form a high impedance r.f. signal divider at the output of the attenuator which is used to sense the r.f. present at the output of the attenuator. Diodes D1 and D2 detect the signal level and the resulting d.c. is connected for use in the r.p.p. system. If the signal level exceeds a preset limit the reed relay RLF is set to the open circuit condition in order to protect the attenuator from excessive power dissipation. The decoupling capacitors C1, C2 result in the detector being more sensitive to very low frequencies than to r.f. This ensures that it is not possible to damage the attenuator with externally applied d.c.

155. The reed relay RLF is mounted in a coaxial tube to ensure that the v.s.w.r. of the reed assembly is very low. It should be noted that the reed should be handled very carefully since it is fragile and is particularly prone to damage around the glass seals at each end. The reed is operated by the magnetic field from the inductor Ll. Ll is wound on a bobbin and the reed relay, surrounded by its coaxial tube, is slid up the centre of the bobbin.

AT2 - Attenuator control

Circuit diagram : Chap. 7, Fig. 26

156. Board AT2 controls the attenuator pads and the r.p.p. detector system. The board is located directly above the attenuator casting. The control lines that energize the attenuator pad solenoids come onto the board via PLAE from the motherboard AD2. When one of these lines is grounded by the open collector driver on AD2, current flows through the corresponding solenoid and the solenoid armature moves across and operates the attenuator microswitch.

157. When a solenoid is energized (control line grounded) the attenuator pad is switched <u>out</u> of circuit. The Zener diodes D4 to D8 act as clamps to protect the open collector drivers on the motherboard. When a solenoid is deenergized the stored magnetic field causes a large voltage spike on the control lines whose amplitude is clamped by the Zener diodes.

158. The power for the solenoids is supplied by PLP, pin 1. Normally this supply is at approximately +9 V. This, by itself, is not adequate to pull in the solenoids, therefore when the microprocessor updates the attenuator setting, supply to the solenoids is temporarily increased to approximately 20 V for 50 ms. This is accomplished by the monostable IC4 and transistors TR2 and TR3. When the attenuator setting is updated by A6L10 instruction at PLV, pin 6, IC4 triggers producing a 50 ms pulse on pin 8 to turn on TR2/TR3. This effectively connects the +20 V supply to PLP, pin 1. Diode D11 prevents the two supplies from shorting together. When TR3 turns off, D11 turns back on to restore a Chap. 4

- +9 V supply. The use of this pulsed supply reduces the power consumption of the attenuator solenoids.
- 159. The r.p.p. is also controlled on AT2. The output from the peak detectors used to detect the application of reverse power to the attenuator board AT1 is fed in to AT2 at PLN, pins 1, 3 and 4. IC1 detects the difference voltage between these detector outputs. The output on IC1, pin 6 is then compared with a reference on IC2.
- 160. If the detected signal level is excessive IC2, pin 7 is asserted 'high' resetting the R-S flip-flop formed by IC3. This results in IC3, pin 13 going 'high' turning off TR1. The voltage on PLN, pin 1 then falls to zero and the reed relay on AT1 attenuator is open circuited. The reaction time between the application of reverse power and the reed relay going open circuit is typically 80 μ s. The Zener diode, D3, protects TR1 against the voltage transient when power is removed from the reed relay's operating inductor (1.e.d. D10 is on when the reed relay is closed to indicate that operation is normal).
- 161. When the reed relay goes open circuit the RPP ACTIVE line on PLV, pin 9 is asserted 'high'. This line is connected to the keyboard AD4 where the microprocessor detects its operation and responds accordingly. The r.p.p. is reset when the microprocessor sets the RPP RESET line on PLV, pin 12 to the 'low' state and then subsequently sets to 'high' again.

AGO - GPIB adaptor module

Circuit diagram: Chap. 7, Fig. 27

- 162. This module is an optional item and only fitted to 2018/2019 when remote facilities are required. The module when connected to the rear panel, allows direct connection from a GPIB talker/listener device and implements the full IEEE 488 specifications (no control function).
- 163. IC2 (8291) GPIB talker/listener integrated circuit is connected to AA2 microprocessor via SKAK and AD2 motherboard providing both talker and listener capabilities, details of these are given in Chapter 3 of the Operating Manual. IC3a and IC8 determine the read and write address decoding cycle. IC1 operates as an independent clock whose frequency (between 1 and 2 MHz) is used to time out an approximate 2 µs delay allowing the bus to settle after sending data.
- 164. IC4 IC7 transceivers are used to translate the negative true logic and act as drivers. IC3b provides the logic 'low' level for the receive instruction TR/1 to IC5, pins 7, 9; or the talker 'high' level for IC5, IC6 and IC7 and also provides the additional buffering necessary for the three IC's in line.

SECOND FUNCTION OPERATIONS

165. Second function operations provide the means of controlling various secondary features and calibrations within the instrument. There are three levels of operation, two of which require unlocking in order to gain access. Each level of operation and method of access is described below.

166. Normal operation

Second functions '0' Unlock

'l' Status information

These functions are unprotected and may be accessed directly:-

'2' GPIB address setting Press SECOND FUNCT followed by '3' Manual latch setting 0, 1, 2 or 3 key as required. Press SECOND FUNCT followed by

167. First level operation

Second functions '4' SRQ mask setting

'6' RF level offset

'-' RECALL STORE 10 at switch-on.

These functions have first '5' RF level units setting degree protection and are accessed by the following procedure: - Press SECOND FUNCT, O, then the MOD OSC and ON/OFF keys simultaneously, holding these down for a minimum of 5 seconds. Follow this by pressing SECOND FUNCT and the numeral 4, 5, 6 or '-' as required.

168. Second level operation

Second functions '7' RF level calibration

'8' FM calibration

'9' 2018/2019 software flag setting

'.' Calculation and storage of amended EAROM check sum

These functions have second degree protection and access to Second level operation is restricted to authorized calibration units only. Interference with these second functions could invalidate the instrument's calibration.

169. Second function '3' Manual latch setting

Second functions 0, 1, 2, 4, 5, 6 and '-' are fully described in Vol. 1. Operating Manual. Second function 3, Manual latch setting, allows the operator to direct an 8 bit binary instruction to any of the instrument's internal latches for testing and fault-finding. The latch is selected first by selecting the SECOND FUNCT 3 mode then entering the number of the data valid line (1 digit 4 to 7), this information is displayed in the Modulation display This is followed by the number of the latch (2 digits 00 to 15) and is displayed in the RF level display window. The data is then entered in binary (8 binary digits 0000 0000 to 1111 1111) and is displayed in the Carrier Frequency display window. The data is sent to the requested latch on pressing the 'STORE' key. New data may be sent without re-entering the latch address if required.

170. Further details of the control data used for individual boards is given in Chap. 5, Maintenance. The example following illustrates the procedure for setting the control data to a board such as AC5, Amplitude modulator.

To set 30% modulation on the board carry out the steps (1) to (3) as follows:-

Chap. 4 Page 38 a

MODULATION

Latch address for AC5 board is A7L0

(1) Address (A7); Press the numeral 7 on the keyboard, display shows:-

(2) Latch (L0); Press the numeral 0 on the keyboard twice (L0 implies L00), display shows:-

(3) 30% Modulation; To obtain 30% modulation, set a binary 30 in the Carrier Frequency display by entering either 1's or 0's from the keyboard, numbers are rotated in from the right,

display shows:-

CARRIER FREQUENCY

To complete the operation press the STORE key.

171. Second function '7' RF level calibration setting

The output level is calibrated by setting a control number (0 - 255) at 10 MHz and 520 MHz (and 1040 MHz for 2019) via second function 5. At all other frequencies the required control data is calculated from these numbers. The instrument allows access to one of these numbers at a time, according to the current carrier frequency. The current value is shown in the RF level display window when second function 7 is selected: a new number may be entered via the keyboard, (or GPIB) or the displayed number changed using the UP and DOWN keys. The output level changes accordingly: to store the new number press the 'STORE' key.

172. Second function '8' FM tracking

The frequency deviation when f.m. is selected is calibrated at 84 frequencies: at other frequencies the required data is calculated internally from the adjacent tracking point data. In order to set a calibration figure at a tracking point, the generator must first be set to the required frequency, with f.m. on, in the normal way. Second function 8 will then display the current calibration number in the RF level display window. This number may be changed by entering a new number, or incremented using the UP and DOWN keys for convenient fine control: the change is effective immediately. The STORE key is used to overwrite the old number with the new: until this happens no permanent change to the calibration data is effected.

173. Should the generator be tuned to a frequency which does not correspond to a tracking point, second function 8 will display the "---" (retuning required) message.

174. Second function '9' 2018/2019 software flag setting

This software package is suitable to drive both the 2018 (520 MHz) and 2019 (1040 MHz) signal generators: second function 9 informs the microprocessor which instrument it is driving. Operation is as for alternative level calibration data selection: '1' indicates 2019; 0, 2018.

175. Second function ''' (decimal point). Calculation and storage of amended EAROM check sum. The initial operating mode of the instrument should be shown on the front panel display at switch on. This is CARRIER FREQ 520 MHz (2019, 1040 MHz) internal MOD OSC 1 kHz, no FM or AM MODULATION and minimum RF LEVEL (-127 dBm or equivalent). Before this occurs a check on the service-ability of the RAM and PROM is carried out and a check sum is also carried out on the EAROM stored data. If this is in error the instrument will be unable to take up the initial operating mode and will instead display the following error signal 'L' in the modulation window. At the same time an indication of the program

mod state is also shown in the carrier frequency window. Earlier instruments, serial numbers 118401 having eight PROMs 44533-025C fitted and with a program mod state of either 01, 02, 03 or 04 do not carry the EAROM check sum capability.

176. The EAROM store carries the RF level calibration and FM tracking data. If this has been changed (as a result of recalibration) the check sum will not agree, therefore it is necessary to select Second function '.'. This operation calculates and subsequently stores the amended data for use thereafter as the valid check sum.

177. If the check sum is incorrect for reasons other than recalibration and this is considered an acceptable condition the instrument may be reset and used in the normal manner by pressing any of the front panel keys on the keyboard.

NOTES AND CAUTIONS

ELECTRICAL SAFETY PRECAUTIONS

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, short together the L (live) and N (neutral) pins of the mains plug.

Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous.

Fuses

Note that there is a supply fuse in both the live and neutral wires of the supply lead. If only one of these fuses should rupture, certain parts of the equipment could remain at supply potential.

To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

RADIO FREQUENCY INTERFERENCE

This equipment conforms with the requirements of IEC Directive 76/889 as to limits of r.f. interference.

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CAUTION: STATIC SENSITIVE COMPONENTS

Components identified with the symbol on the circuit diagrams and/or parts lists are static sensitive devices. The presence of such devices is also indicated in the equipment by orange discs, flags or labels bearing the same symbol. Certain handling precautions must be observed to prevent these components being permanently damaged by static charges or fast surges.

- (1) If a printed board containing static sensitive components (as indicated by a warning disc or flag) is removed, it must be temporarily stored in a conductive plastic bag.
- (2) If a static sensitive component is to be removed or replaced the following anti-static equipment must be used.

A work bench with an earthed conductive surface.

Metallic tools earthed either permanently or by repeated discharges.

A low-voltage earthed soldering iron.

An earthed wrist strap and a conductive earthed seat cover for the operator, whose outer clothing must not be of man-made fibre.

(3) As a general precaution, avoid touching the leads of a static sensitive component. When handling a new one, leave it in its conducting mount until it is required for use.

WARNING: HANDLING HAZARDS

This equipment is formed from metal pressings and although every endeavour has been made to remove sharp points and edges care should be taken, particularly when servicing the equipment, to avoid minor cuts.

WARNING: TOXIC HAZARD

Many of the electronic components used in this equipment employ resins and other chemicals which give off toxic fumes on incineration. Appropriate precautions should therefore be taken in the disposal of these items.



Beryllia (beryllium oxide) is used in the construction of the following components in this equipment:

Unit AC4: Transistor TR10

This material, when in the form of fine dust or vapour and inhaled into the lungs, can cause a respiratory disease. In its solid form, as used here, it can be handled quite safely although it is prudent to avoid handling conditions which promote dust formation by surface abrasion.

Because of this hazard you are advised to be very careful in removing and disposing of these components. Do not put them in the general industrial or domestic waste or despatch them by post. They must be separately and securely packed and clearly identified to show the nature of the hazard and then disposed of in a safe manner by an authorized toxic waste contractor.

Chapter 5

MAINTENANCE

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Annex

A Measurement of phase noise in signal generators

INTRODUCTION

- 1. This chapter contains information for keeping the equipment in good working order, checking overall performance, fault finding and realignment procedures. Before attempting any maintenance on the equipment you are advised to read the preceding chapter containing the technical description.
- 2. Test procedures described in this chapter may be simplified and of restricted range compared with those that relate to the generally more comprehensive factory test facilities, which are necessary to demonstrate complete compliance with the specifications.
- 3. Performance limits quoted are for guidance and should not be taken as guaranteed performance specifications unless they are also quoted in the performance data in Chap. 1. When making tests to verify that the instrument meets the stated performance limits, allowance must always be made for the uncertainty of the test equipment used.
- 4. In case of difficulties which cannot be resolved with the aid of this book, please contact our Service Division at the address given inside the rear cover, or your nearest Marconi Instruments representative. Always quote the type and serial number found on the data plate at the rear of the instrument.
- 5. Integrated circuit and semiconductor devices are used throughout this instrument and, although these have inherent long term reliability and mechanical ruggedness, they are susceptible to damage by overloading, reverse polarity and excessive heat or radiation and the use of insulation testers.
- 6. Numerous chip capacitors and resistors are fitted in this equipment. These have silver palladium end cap terminations. When soldering these devices the following precautions should be observed.
 - (i) Use solder containing 2% silver, and a temperature controlled 45 watt soldering iron set to 315°C (600°F). The use of a high wattage soldering iron will minimize the time taken to solder the device.
 - (ii) When soldering chip components to printed circuit boards a long fillet of solder should be laid on the track leading up to each end cap termination. This reduces the otherwise adverse inductive effects at high frequencies.
- 7. Static sensitive components. A The c.m.o.s. integrated circuits used in this instrument have extremely high input resistance and can be damaged by accumulation of static charges (see preliminary pages, Notes and Cautions). Boards that have such integrated circuits all carry warning notices against damage by static discharge.
- 8. Beryllia health hazard. This material is used in the construction of transistor TR10 in Unit AC4. Warning notices are displayed and extreme care must be exercised when wishing to disturb this transistor (see preliminary pages, Notes and Cautions).
- 9. Bulkhead connectors and gaskets. Special care should be taken to ensure that no r.f. leakage occurs. To this end all bulkhead connectors and lid sealing gaskets should be secure. It is essential that the unit lids be correctly relocated in their slotted recesses after removal.

10. Fault location. Some aid to fault finding is provided by the typical d.c. voltage and signal levels. Tables given are not extensive but are intended as a pointer to further investigation. It is emphasized that each fault table should be studied having regard for the others, since incorrect operation of a circuit may be caused by malfunction of an associated circuit.

PERFORMANCE CHECKS

Overall tests and adjustments

11. Many of the tests described in this chapter are simplified and of restricted range compared with those which would demonstrate compliance with the specification as described in paras. 1 to 4. If the results quoted in the following paragraphs are not obtainable refer to the related fault finding section and tables, and after repair ensure that realignment is carried out in accordance with that section, if applicable.

Frequency accuracy

Test equipment: items d, Digital frequency meter
n, Standard frequency source (10 MHz)

- 12. (1) Connect the frequency meter to the output of the instrument.
 - (2) It is advisable to synchronize the frequency meter with an external standard frequency accuracy 2 parts in 108 if possible.
 - (3) With the 2018 in any mode of operation and the INT standard selected carry out spot checks throughout the range of the instrument and ensure that frequencies are within specifications.
 - (4) Check that the output from the rear panel STD FREQ IN-OUT socket is a nominal 3 V p-p frequency signal at 10 MHz ±1 Hz. The standard frequency trim RI can be accessed through the upper right-hand side outer cover and enables the internal standard to be set against a primary external standard.

CAUTION. A

Incorrect adjustment of this preset will impair the frequency accuracy of the generator. Allow at least 10 minutes warm-up and switch the frequency counter to Select 'B' 1 Hz resolution. Adjust R1 for a reading of 10 MHz ±1 Hz then switch the frequency counter to 0.1 Hz resolution and check that the indication is the same after five counter gates.

TABLE 1 TEST EQUIPMENT

Item	Description	Minimum use specifications	Recommended model
a	RF electronic millivoltmeter	Voltage range: 1mV to 3V r.m.s. Frequency range: 50kHz to 520MHz (2018), 1040MHz (2019). Accuracy: ±5% of f.s.d. up to 50MHz ±2dB up to 900MHz, ±3dB up to 1500MHz (using coaxial 'T' connector TM 7948).	TF 2603
b	T connector	VSWR $ extrm{\downarrow} $ 1.2:1 at 1500MHz, terminated in 50 Ω .	TM 7948
С	N type 50Ω load	VSWR > 1.05:1 up to 1500MHz.	TM 7967
d	Digital frequency meter	Frequency range: 10Hz to 2GHz. Sensitivity: 56mV r.m.s. p.d. into 50Ω . Input impedance: LF lMHz in parallel with less than 25pF . Nominal 50Ω .	2435
е	Multimeter	Greater than $20k\Omega/V$.	GEC Selectest
f	Power meter & tft power head		
g	Distortion factor meter	Factor Fundamental rejection: 80dB.	
h	AM/FM modulation meter with crystal osc.	eter with Deviation range: 1.5 to 500kHz.	
i	AF oscillator	F oscillator Frequency range: 10Hz to 110kHz Accuracy: ±3% of reading. Distortion: Better than -100dB from 10Hz to 30kHz. Level: 0 to 3V.	
j	Digital voltmeter	DC volts. Ranges: ±10mV to ±1000V. Resolution: 0.01% of range (10µV on 100mV range). Accuracy: ±100mV range ±(0.05% of input +0.02% of range). ±1V to 1000V range ±(0.02% of input +0.01% of range).	
k	(i) Spectrum analyser (ii) Frequency extender (iii) Zero loss probe	Frequency range: 10kHz to 1.25GHz Variable persistance/storage display	TF 2370/TK 2373 & TK 2374

TABLE 1 TEST EQUIPMENT (continued)

tem	Description	Minimum use specifications	Recommended model
1	AF voltmeter	Range: 1mV to 100V f.s.d. Frequency range: 10Hz to 10MHz. Accuracy: ±1%.	TF 2600B
m	Oscilloscope with dual trace capability	Bandwidth: $50M\Omega$. Volts/division: $5mV$ to $20V$.	TELEQUIPMENT D83 with V4 dual channel wide band amp. plug-in.
n	Standard frequency source (10MHz)	Output level: 4V p-p. Frequency accuracy: 2 parts in 10 ⁸ .	Rubidium or Caesium reference unit
0	Variable d.c. power supply	0 to 30V d.c. at 1A.	TF 2155/1
р	Sweep oscillator & RF plug-in unit	Frequency range: 5MHz to 2GHz. Sweep output: +2V to +10V. Markers, amplitude -5V F1-F2 symmetrical sweep.	6700B/6730A
q	Rho-bridge with two standard 50Ω loads and calibrated mismatched loads	Frequency range: 1MHz to 1GHz. Residual v.s.w.r.: \$ 1.01:1 from 5MHz to 1GHz. Characteristic impedance: 50Ω. Calibrated mismatched loads: 1.2:1, 1.5:1. Two standard 50Ω loads, v.s.w.r. better than 1.02:1 from 1MHz to 1GHz.	

TABLE 2 DECIBEL CONVERSION TABLE

Ratio	Down		Rat	io Up
OLTAGE	POWER	DECIBELS	VOLTAGE	POWER
1.0	1.0	0	1.0	1.0
-9886	·9772	-1	1.012	1.023
.9772	·9550	·2	1.023	1.047
-9661	·9333	-3	1.035	1.072
.9550	·9120	.4	1.047	1.096
·9441	·8913	.5	1.059	1.122
.9333	·8710	-6	1.072	1.148
.9226	·8511	· 7	1.084	1.175
·9120	⋅8318	.8	1.096	1.202
.9016	·8128	.9	1.109	1-230
·8913	·7943	1.0	1.122	1.259
·8710	· 7 586	1.2	1.148	1.318
·8511	·7244	1.4	1.175	1.380
·8318	∙6918	1.6	1.202	1.445
·8128	·660 7	1.8	1.230	1.514
·7943	-6310	2.0	1.259	1.585
·7762	·6026	2.2	1.288	1.660
·7586	·5754	2.4	1.318	1.738
·7413	·5495	2.6	1.349	1.820
.7244	·5248	2.8	1.380	1.905
·7079	·5012	3.0	1.413	1.995
-6683	·4467	3.5	1.496	2.239
-6310	·3981	4.0	1.585	2.512
.5957	·3548	4.5	1.679	2.818
·5623	·3162	5.0	1.778	3.162
·5309	·2818	5.5	1.884	3.548
·5012	·2512	6	1.995	3.981
•4467	·1995	7	2.239	5.012
•3981	·1585	8	2.512	6.310
·3548	·1259	9	2.818	7.943
·3162	·1000	10	3.162	10.000
·2818	·07943	11	3.548	12.59
·2512	·06310	12	3.981	15.85
·2239	·05012 ·03981	13	4·467 5·012	19·95 25·12
·1995 ·1778	·03981 ·03162	14 15	5·623	31.62

TABLE 2 - DECIBEL CONVERSION TABLE (continued)

-1585	Ratio E	Down	Ratio Up			
-1413	VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER	
-1259	·1585	·02512	16	6.310	39.81	
1122	-1413	-01995	17	7.079		
-1000						
1585 109						
06310	-1000	.01000	20	10.000	100.00	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						
-03162						
-02512						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	·03162	1·000 × 10-3	30	31.62	1,000	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						
1.5943 x 10 ⁻³						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$.01000	1.000 x 10°°	40	100.00	1.000 X 10.	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	7.943 x 10 ⁻³	6.310×10^{-5}	42	125.9	1.585 x 10⁴	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	5.310×10^{-3}					
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	1·162 x 10⁻³	1.000 × 10 ⁻⁵	50	316-2	1.000 x 10 ⁵	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$.·512 × 10 ⁻³					
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$						
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	·000 x 10 ⁻³	1·000 x 10 ⁻⁶	60	1,000	1·000 × 10°	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	·623 x 10 ⁻¹					
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	·623 X 10 ⁻³	3·162 × 10 ⁻⁷	85	1·//8 x 10°	3·162 × 10°	
$^{\cdot 162} \times 10^{-6}$ 1.000×10^{-11} 110 3.162×10^{5} 1.000×10^{11} $\cdot 000 \times 10^{-6}$ 1.000×10^{-12} 120 1.000×10^{6} 1.000×10^{12} $\cdot 162 \times 10^{-7}$ 1.000×10^{-13} 130 3.162×10^{6} 1.000×10^{13}	·162 x 10 ⁻⁵					
0.000×10^{-6} 1.000×10^{-12} 120 1.000×10^{6} 1.000×10^{12} 1.000×10^{-13} 130 1.000×10^{13}						
$\cdot 162 \times 10^{-7}$ 1.000×10^{-13} 130 3.162×10^{6} 1.000×10^{13}						
	·162 x 10 ⁻⁷	1.000×10^{-13} 1.000×10^{-14}	130 140	$3 162 \times 10^{\circ}$ 1.000×10^{7}	1.000×10^{13} 1.000×10^{14}	

TABLE 3 dByV CONVERSION TABLE

dBm	EMF (r.m.s.)	dΒμV (e.m.f.)	dBm	EMF (r.m.s.)	$dB\mu V$ (e.m.f.)	dBm	EMF (r.m.s.)	dBμV (e.m.f.)
-130	.141µV	-17	-80	44.7μV	+33	-30	14.1mV	+83
-129	.159	-16	-79	50.2	+34	-29	15.9	+84
-128	.178	-15	-78	56.3	+35	-28	17.8	+85
-127	.200	-14	-77	63.2	+36	-27	20.0	+86
-126	.224	-13	-76	70.9	+37	-26	22.4	+87
-125	.251	-12	-75	79.5	+38	-25	25.1	+88
-124	.282	-11	-74	89.2	+39	-24	28.2	+89
-123	.317	-10	-73	100	+40	-23	31.7	+90
-122	.355	-9	-72	112	+41	-22	35.5	+91
-121	.399	-8	-71	126	+42	-21	39.9	+92
-120 -119 -118 -117 -116	.447 .502 .563 .632	-7 -6 -5 -4 -3	-70 -69 -68 -67 -66	141 159 178 200 224	+43 +44 +45 +46 +47	-20 -19 -18 -17 -16	44.7 50.2 56.3 63.2 70.9	+93 +94 +95 +96 +97
-115	.795	-2	-65	251	+48	-15	79.5	+98
-114	.892	-1	-64	282	+49	-14	89.2	+99
-113	1.00	0	-63	317	+50	-13	100	+100
-112	1.12	+1	-62	355	+51	-12	112	+101
-111	1.20	+2	-61	399	+52	-11	126	+102
-110	1.41	+3	-60	447	+53	-10	141	+103
-109	1.59	+4	-59	502	+54	-9	159	+104
-108	1.78	+5	-58	563	+55	-8	178	+105
-107	2.00	+6	-57	632	+56	-7	200	+106
-106	2.24	+7	-56	709	+57	-6	224	+107
-105	2.51	+8	-55	795	+58	-5	251	+108
-104	2.82	+9	-54	892	+59	-4	282	+109
-103	3.17	+10	-53	1.00mV	+60	-3	317	+110
-102	3.55	+11	-52	1.12	+61	-2	355	+111
-101	3.99	+12	-51	1.26	+62	-1	399	+112
-100	4.47	+13	-50	1.41	+63	0	447	+113
-99	5.02	+14	-49	1.59	+64	+1	502	+114
-98	5.63	+15	-48	1.78	+65	+2	563	+115
-97	6.32	+16	-47	2.00	+66	+3	632	+116
-96	7.09	+17	-46	2.24	+67	+4	709	+117
-95	7.95	+18	-45	2.51	+68	+5	795	+118
-94	8.92	+19	-44	2.82	+69	+6	892	+119
-93	10.0	+20	-43	3.17	+70	+7	1.00V	+120
-92	11.2	+21	-42	3.55	+71	+8	1.12	+121
-91	12.6	+22	-41	3.99	+72	+9	1.26	+122
-90	14.1	+23	-40	4.47	+73	+10	1.41	+123
-89	15.9	+24	-39	5.02	+74	+11	1.59	+124
-88	17.8	+25	-38	5.63	+75	+12	1.78	+125
-87	20.0	+26	-37	6.32	+76	+13	2.00	+126
-86	22.4	+27	-36	7.09	+77	+14	2.24	+127
-85 -84 -83 -82 -81	25.1 28.2 31.7 35.5 39.9	+28 +29 +30 +31 +32	-35 -34 -33 -32 -31	7.95 8.92 10.0 11.2 12.6	+78 +79 +80 +81 +82	+15 +16 +17 +18 +19 +20	2.51 2.82 3.17 3.55 3.99 4.47	+128 +129 +130 +131 +132 +133

TABLE 2 - DECIBEL CONVERSION TABLE (continued)

Ratio I	Down	Ratio Up			
/OLTAGE	POWER	DECIBELS	VOLTAGE	POWER	
·1585	·02512	16	6.310	39.81	
·1413	01995	17	7.079	50.12	
·1259	·01585	18	7.943	63.10	
·1122	.01259	19	8.913	79.43	
·1000	·01000	20	10-000	100.00	
.07943	6·310 x 10 ⁻³	22	12-59	158.5	
-06310	3.981×10^{-3}	24	15.85	251.2	
.05012	2.512×10^{-3}	26	19.95	398-1	
-03981	1.585×10^{-3}	28	25 12	631.0	
·03162	1·000 x 10 ⁻³	30	31.62	1,000	
.02512	6·310 x 10 ⁻⁴	32	39.81	1.585×10^{3}	
.01995	3.981 x 10 ⁻⁴	34	50.12	2.512×10^{3}	
.01585	2·512 x 10 ⁻⁴	36	63.10	3.981×10^{3}	
.01259	1 585 x 10 ⁻⁴	38	79.43	6.310×10^3	
·01000	1.000 × 10 ⁻⁴	40	100.00	1.000 x 10 ⁴	
1.943×10^{-3}	6·310 x 10 ⁻⁵	42	125.9	1.585 x 10⁴	
$\cdot 310 \times 10^{-3}$	3.981×10^{-5}	44	158.5	2.512 x 10 ⁴	
0.012×10^{-3}	2.512×10^{-5}	46 .	199.5	3.981 x 10 ⁴	
981 x 10 ⁻³	1.585×10^{-5}	48	251.2	6·310 x 10 ⁴	
·162 x 10 ⁻³	1.000 × 10 ⁻⁵	50	316-2	1.000 x 10 ⁵	
·512 x 10 ⁻³	6·310 x 10 ⁻⁶	52	398-1	1.585 x 10 ^s	
$.995 \times 10^{-3}$	3⋅981 x 10 ⁻⁶	54	501.2	2.512×10^{5}	
$\cdot 585 \times 10^{-3}$	2·512 x 10 ⁻⁶	56	631.0	3.981 x 10 ⁵	
·259 x 10 ⁻³	1.585 x 10 ⁻⁶	58	794.3	6.310×10^{5}	
$\cdot 000 \times 10^{-3}$	1.000 × 10 ⁻⁶	60	1,000	1.000 x 10 ⁶	
·623 x 10 ⁻⁴	3.162×10^{-7}	65	1.778×10^3	3·162 × 10°	
·162 × 10-1	1.000×10^{-7}	70	3.162×10^{3}	1.000×10^7	
·778 x 10-4	3·162 x 10 ⁻⁸	75	5.623×10^{3}	3.162×10^7	
·000 x 10 ⁻⁴	1.000×10^{-8}	80	1.000 × 10 ⁴	1.000×10^8	
·623 x 10⁻⁵	3·162 × 10 ⁻⁹	85	1.778 x 10 ⁴	3·162 × 10 ⁸	
·162 x 10 ⁻⁵	1.000 x 10 ⁻⁹	90	3·162 × 10⁴	1.000 x 10°	
0.000×10^{-5}	1.000×10^{-10}	100	1.000×10^{5}	1.000×10^{10}	
·162 × 10-6	1.000×10^{-11}	110	3·162 x 10 ⁵	1.000 x 10 ¹¹	
·000 × 10-6	1.000×10^{-12}	120	1.000 x 10 ⁶	1.000×10^{12}	
·162 x 10 ⁻⁷ ·000 x 10 ⁻⁷	1.000×10^{-13} 1.000×10^{-14}	130 140	3 162 x 10 ⁶ 1.000 x 10 ⁷	1.000×10^{13} 1.000×10^{14}	

dBm	EMF	dB _U V	d.Bm	EMF	$dB\mu V$	dBm	EMF	$dB\mu V$
	(r.m.s.)			(r.m.s.)			(r.m.s.)	
-130	.141µV	-17	-80	44.7μV	+33	-30	14.1mV	+83
-129	.159	-16	-79	50.2	+34	-29	15.9	+84
-128	.178	-15	-78	56.3	+35	-28	17.8	+85
-127	.200	-14	-77	63.2	+36	-27	20.0	+86
-126	.224	-13	-76	70.9	+37	-26	22.4	+87
-125	.251	-12	-75	79.5	+38	-25	25.1	+88
-124	. 282	-11	-74	89.2	+39	-24	28.2	+89
-123	.317	-10	-73	100	+40	-23	31.7	+90
-122	.355	-9	-72	112	+41	-22	35.5	+91 +92
-121	.399	-8	-71	126		-21	39.9	
-120	. 447	-7	-70	141	+43	-20	44.7	+93
-119	. 502	-6	-69	159	+44	-19	50.2	+94
-118	. 563	-5	-68	178	+45	-18	56.3	+95
-117	.632	-4	-67	200	+46	-17 -16	63.2 70.9	+96 +97
-116	.700	-3	-66	224	+47			
-115	.795	-2	-65	251	+48	~15	79.5	+98
-114	.892	-1	-64	282	+49	-14	89.2	+99
-113	1.00	0	-63	317	+50	-13	100	+100
-112	1.12	+1	-62	355	+51	-12	112	+101 +102
-111	1.20	+2	-61	399	+52	-11	126	
-110	1.41	+3	-60	447	+53	-10	141	+103
-109	1.59	+4	-59	502	+54	-9	159	+104
-1 08	1.78	+5	- 58	563	+55	-8	178	+105
-107	2.00	+6	-57	632	+56	-7	200	+106 +107
-106	2.24	+7	- 56	709	+57	-6	224	
-105	2.51	+8	-55	795	+58	-5	251	+108
-104	2.82	+9	- 54	892	+59	-4	282	+109
-103	3.17	+10	-53	1.00mV	+60 +61	-3	317 355	+110 +111
-102 -101	3.55 3.99	+11 +12	-52 -51	1.12	+62	-2 -1	399	+112
-100	4.47	+13	-50	1.41	+63 +64	0 +1	447 502	+113 +114
-99 -98	5.02 5.63	+14 +15	-49 -48	1.78	+65	+1	563	+115
-98 -97	6.32	+15	-40	2.00	+66	+3	632	+116
- 96	7.09	+17	-46	2.24	+67	+4	709	+117
-95	7.95	+18	-45	2.51	+68	+5	795	+118
-95 -94	7.95 8.92	+18	-45 -44	2.82	+69	+6	892	+119
-94 -93	10.0	+20	-43	3.17	+70	+7	1.00V	+120
- 92	11.2	+21	-42	3.55	+71	+8	1.12	+121
-91	12.6	+22	-41	3.99	+72	+9	1.26	+122
-90	14.1	+23	-40	4.47	+73	+10	1.41	+123
- 89	15.9	+24	-39	5.02	+74	+11	1.59	+124
-88	17.8	+25	-38	5.63	+75	+12	1.78	+125
-87	20.0	+26	-37	6.32	+76	+13	2.00	+126
-86	22.4	+27	-36	7.09	+77	+14	2.24	+127
-85	25.1	+28	-35	7.95	+78	+15	2.51	+128
-84	28.2	+29	-34	8.92	+79	+16	2.82	+129
-83	31.7	+30	-33	10.0	+80	+17	3.17	+130
-82	35.5	+31	-32	11.2	+81	+18	3.55	+131
-81	39.9	+32	-31	12.6	+82	+19	3.99	+132
						+20	4.47	+133_

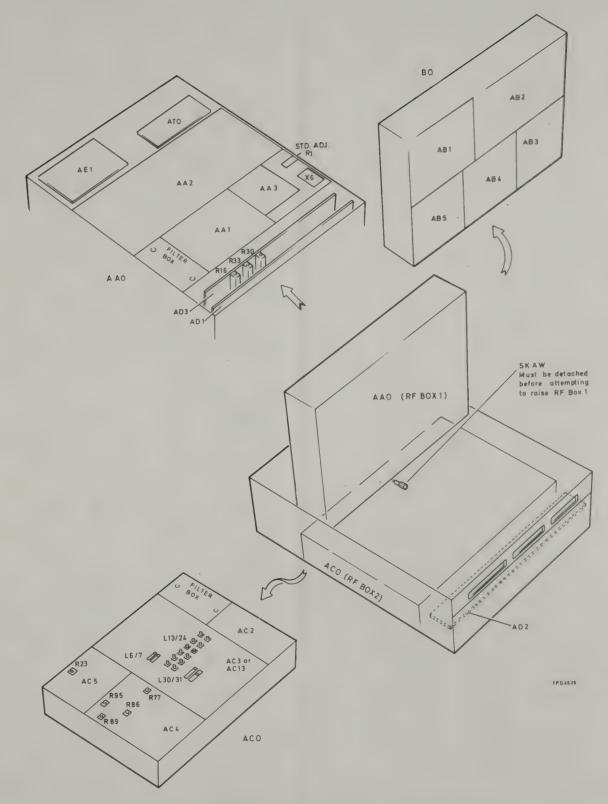
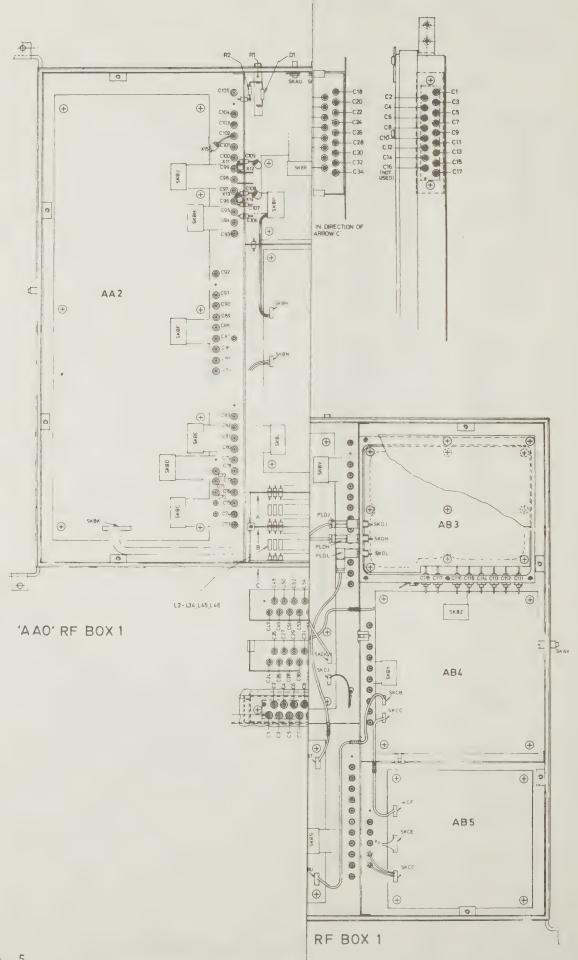


Fig. 1a Board location, access and pre-set adjustments



RF output

Test equipment: items a, RF electronic voltmeter

b, T connector

c, N type 50 Ω load

f, Power meter

13. The a.1.c. and fine attenuator output level is accurate to within ± 0.5 dB for carrier frequencies up to 520 MHz and within ± 1.0 dB for carrier frequencies from 520 to 1040 MHz. Test equipment shown in Fig. 2 below enables the output to be checked for carrier frequencies up to 50 MHz only. Output levels at frequencies higher than this should be checked using a power meter fitted with the appropriate tft head.

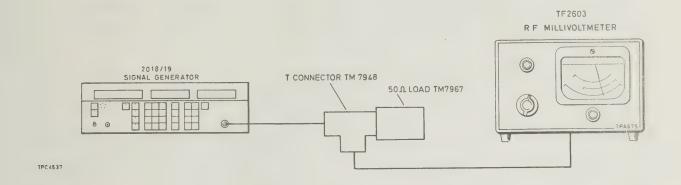


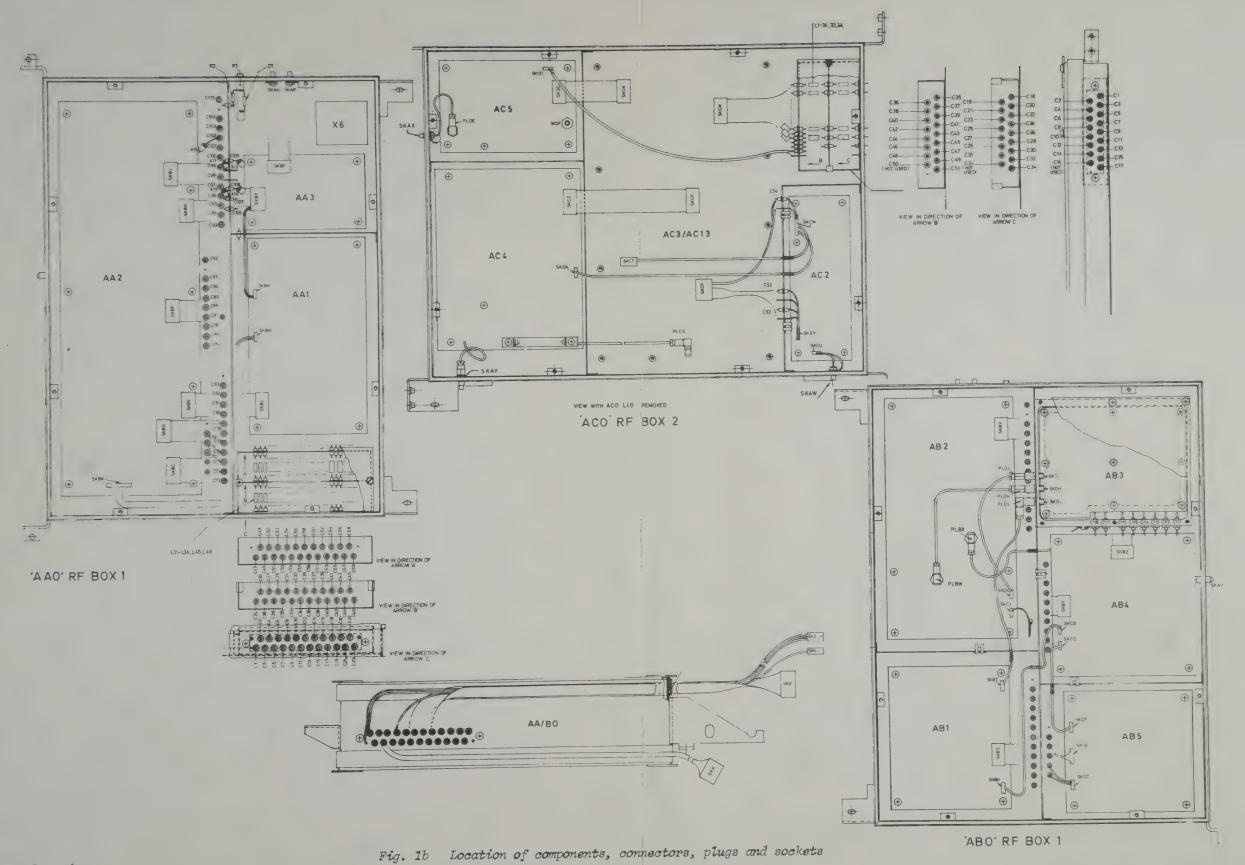
Fig. 2 Test gear arrangement for r.f. output measurements

14. Select an appropriate carrier frequency, AM OFF, RF LEVEL +13 dBm, increment the RF LEVEL in steps of 0.1 dB and check that the output level remains accurate down to a level of -3 dBm. Selection of levels below -2.9 dBm include the operation of the coarse attenuator and although the output may be measured at any level low power measurements require the use of specialized attenuator measuring equipment.

Coarse attenuator functional check

Test equipment: item k, Spectrum analyser

- 15. The 10 dB step attenuator contains three 30 dB pads, one 20 dB pad and one 10 dB pad. Each of these may be selected individually by utilizing the second function 3 mode. Connect the spectrum analyser to the RF OUTPUT socket and select +3 dBm on the 2018. The coarse attenuator ATO is controlled from AD2 motherboard, address A6L10. To select each of the relays in turn carry out the following procedure:-
 - (1) Select SECOND FUNCT 3.
 - (2) Select by means of the instrument keyboard, the address valid followed by the address latch number. The modulation display window will indicate 06 and the RF level display window 10.



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RF output

Test equipment: items a, RF electronic voltmeter

b, T connector

c. N type 50 Ω load

f, Power meter

13. The a.1.c. and fine attenuator output level is accurate to within ± 0.5 dB for carrier frequencies up to 520 MHz and within ± 1.0 dB for carrier frequencies from 520 to 1040 MHz. Test equipment shown in Fig. 2 below enables the output to be checked for carrier frequencies up to 50 MHz only. Output levels at frequencies higher than this should be checked using a power meter fitted with the appropriate tft head.

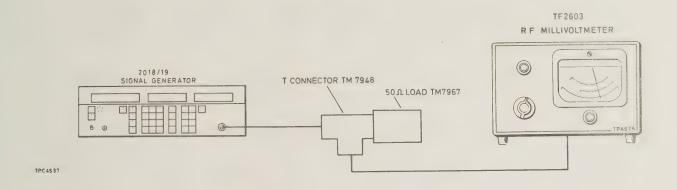


Fig. 2 Test gear arrangement for r.f. output measurements

14. Select an appropriate carrier frequency, AM OFF, RF LEVEL +13 dBm, increment the RF LEVEL in steps of 0.1 dB and check that the output level remains accurate down to a level of -3 dBm. Selection of levels below -2.9 dBm include the operation of the coarse attenuator and although the output may be measured at any level low power measurements require the use of specialized attenuator measuring equipment.

Coarse attenuator functional check

Test equipment: item k, Spectrum analyser

- 15. The 10 dB step attenuator contains three 30 dB pads, one 20 dB pad and one 10 dB pad. Each of these may be selected individually by utilizing the second function 3 mode. Connect the spectrum analyser to the RF OUTPUT socket and select +3 dBm on the 2018. The coarse attenuator ATO is controlled from AD2 motherboard, address A6L10. To select each of the relays in turn carry out the following procedure:-
 - (1) Select SECOND FUNCT 3.
 - (2) Select by means of the instrument keyboard, the address valid followed by the address latch number. The modulation display window will indicate 06 and the RF level display window 10.

(3) Enter the data in binary 1 or 0 from the keyboard, numbers are rotated in from the right and are displayed in the carrier frequency window. Each relay may be selected by the binary number shown below in Table 4.

TABLE 4	ATO	ATTENUATOR	FUNCTIONAL	CHECK

		Bir	ıarı	, No) .			Relay de-energized	Attenuator	pad RF	output
D7	D6	D5	D4	D3	D2	D1	D0				
0	0	1	Ī	1	1	0	1.	RLE	10 dB	-3	d Bm
0	0	1	j	1	0	1	1	RLD	20 dB	-13	dBm
0	0	1	è	0	1	1	1	RLC	30 dB	-23	dBm
0	0	1	0	1	1	1	1	RLB	30 dB	-23	dBm
0	0	0	1	1	1	1	1	RLA	30 dB	-23	dBm

- (4) Check that the output level falls to the appropriate level on the Spectrum analyser as each attenuator pad is selected.
- 16. The only electrical adjustment provided on ATI board is a series of flags which may be used to adjust the calibration of each pad. In the 0 dB attenuation condition the attenuator has an insertion loss which is dependent upon the frequency selected. This insertion loss is compensated for by the ALC system on AC4. The flags are used to adjust the attenuation of each pad so that the difference between the attenuation of each pad being in or out is equal to the nominal attenuation of the pad at 1 GHz. To carry out comprehensive attenuator accuracy checks and realignment requires each pad to be separately set up using specialized measuring facilities and it is recommended that this be carried out only by the nearest Marconi Instruments agent or Service Division.

Modulation oscillator performance

Test equipment: items d, Digital frequency meter g, Distortion factor meter

- 17. To test the frequency, distortion and output of the modulation oscillator proceed as follows:-
 - (1) Connect the frequency meter to the MOD INPUT/OUTPUT socket of the instrument using a BNC type connector (nominal output level and source impedance is 1 V e.m.f. and 1 k Ω respectively).
 - (2) Select by successive presses of the MOD OSC key each of the five pre-set modulation frequencies checking that the frequency indicated corresponds to the one selected ±5% and that each l.e.d. indicator on the instrument is lit as appropriate.
 - (3) Disconnect the frequency meter and connect the distortion factor meter. The measured distortion should not exceed 0.3%.
 - (4) Switch the distortion factor meter to Hi Z and check the output level. This should be greater than 800 mV e.m.f.

FM deviation

Test equipment : item h, AM/FM modulation meter

- 18. To check the deviation accuracy proceed as follows:-
 - (1) Select CARRIER FREQ 100 MHz, MOD OSC 1 kHz, FM 100 kHz.
 - (2) Connect the TF 2300B to the RF OUTPUT socket and tune to the carrier frequency.
 - (3) Measure the deviation and check that it is within $\pm 5\%$ of the selected deviation.
 - (4) Repeat the test for other deviation frequencies within the range of the instrument (1% of the carrier frequency in use).

FM tracking

Test equipment: item h, AM/FM modulation meter

- 19. To check the f.m. tracking proceed as follows:-
 - (1) Connect the modulation meter to the RF OUTPUT socket.
 - (2) Set to FM 100 kHz, MOD OSC 1 kHz, RF LEVEL +1 dBm.
 - (3) Tune modulation meter to various carrier frequencies between 261 and 520 MHz and check that the output deviation remains at 100 kHz ±5%.

AM depth

Test equipment: item h, AM/FM modulation meter

- 20. To check the a.m. depth proceed as follows:-
 - (1) Select CARRIER FREQ 100 MHz, AM 80%, MOD OSC 1 kHz, RF LEVEL +120 dBµV e.m.f.
 - (2) Connect the modulation meter r.f. input to the 2018 RF OUTPUT socket.
 - (3) Tune the modulation meter to the 2018 carrier frequency and check that the a.m. depth is accurate to within $\pm 4\%$ of depth setting $\pm 1\%$.
 - (4) Check the a.m. depth at other carrier frequencies up to 400 MHz.
- 21. If a modulation meter is not available the a.m. depth can be assessed by using an oscilloscope to measure the peak and trough values of the modulation envelope. The a.m. depth is then determined by

AM depth
$$\% = \frac{Vp - Vt}{Vp + Vt} \times 100$$

where Vp and Vt are the measured peak-to-peak and trough-to-trough amplitudes respectively.

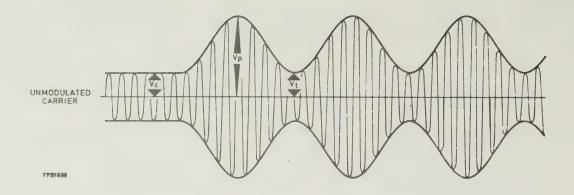


Fig. 3 Modulation depth measurement

External f.m. modulation sensitivity (ALC)

Test equipment: items h, AM/FM modulation meter

i, AF oscillator

1. AF voltmeter

- 22. The modulation level should remain reasonably constant for a given change in external modulation voltage and frequency. This sensitivity is checked as follows:-
 - (1) Connect the test equipment as shown in Fig. 4.
 - (2) Select FM 300 kHz, MOD OSC 1 kHz, CARRIER FREQ 30 MHz, RF LEVEL 0 dBm, check that the internal modulation oscillator frequency is 1 kHz ±40 Hz at a level of 1 V ±0.25 V.
 - (3) Set 2018 to FM EXT, ALC ON, set the AF oscillator to give a 1 kHz, 1 V amplitude output and check that the f.m. deviation is the same as that for internal modulation.
 - (4) Vary the input voltage between 0.8 and 1.2 V and check that the deviation remains constant.

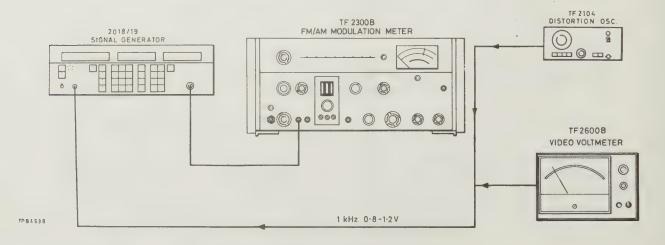


Fig. 4 Test gear arrangement for the checking of external modulation sensitivity

AM distortion

Test equipment: items g, Distortion factor meter h, AM/FM modulation meter

- 23. To check the internal a.m. distortion proceed as follows:-
 - (1) Connect the test equipment as shown in Fig. 5 below.
 - (2) Select CARRIER FREQ 100 MHz, MOD OSC 1 kHz, AM 80%, RF LEVEL 7 dBm.
 - (3) Tune the modulation meter to the 100 mHz signal, checking that the distortion factor does not exceed an indicated 3% reading.
 - (4) Repeat the test with CARRIER FREQ set to 400 MHz.

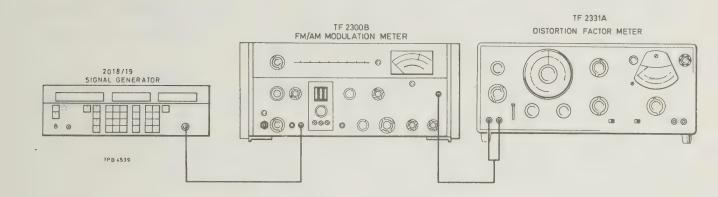


Fig. 5 Test gear arrangement for checking f.m. and a.m. distortion

FM distortion

Test equipment: items g, Distortion factor meter h, AM/FM modulation meter

- 24. To check the f.m. distortion proceed as follows:-
 - (1) Connect the test equipment as shown in Fig. 5. Select CARRIER FREQ 30 MHz, MOD OSC 1 kHz, FM 200 kHz.
 - (2) Tune the modulation meter to the instrument and check that the distortion is not in excess of 3%.
 - (3) Repeat the test for other amounts of deviation. The distortion over the total range should not exceed 3% for deviations of up to 70% of the maximum available at any carrier frequency.

VSWR (5 MHz to 1 GHz)

Test equipment: items m, Oscilloscope with dual trace capability

- p, Sweep oscillator & RF plug-in unit
- q, Rho-bridge with standard loads and calibrated mismatches
- 25. The impedance measurement may be carried out over almost all the frequency range of the instrument. Connect the test equipment as shown in Fig. 6 below.

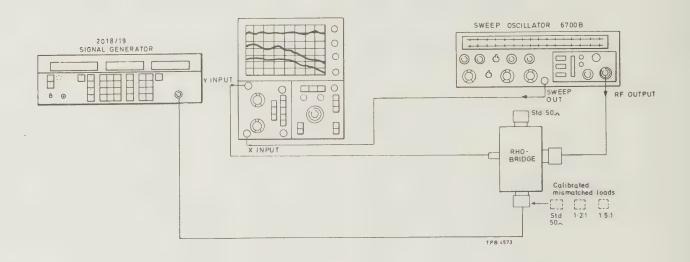


Fig. 6 Test gear arrangement to check v.s.w.r.

- (1) Set the sweep oscillator to F1-F2 and sweep from 5 MHz to 520 MHz, insert standard 50 Ω loads into the rho-bridge and set datum point near the top of the oscilloscope display. Replace one 50 Ω with a 1.2:1 mismatched load and adjust the d.c. output of the rho-bridge so that the vertical deflection of the oscilloscope occupies 5 or 6 c.m.s. for the mismatch change. Using a chinagraph draw the pattern on the oscilloscope graticule.
- (2) Remove the mismatched load and connect the 2018/2019 to the rhobridge instead. Check that the v.s.w.r. does not exceed 1.2:1 with the RF LEVEL selected to -4 dBm or less.
- (3) For 2019 Signal Generators repeat steps (1) and (2) sweeping this time from 5 MHz to 1 GHz and using the 1.5:1 mismatched load to check that the v.s.w.r. does not exceed 1.5:1.

Carrier harmonics and spurious signals

Test equipment: item k, Spectrum analyser

- 26. To check the level of harmonics of the carrier frequency in a c.w. output proceed as follows:-
 - (1) Connect the spectrum analyser to the RF OUTPUT socket and set the instrument to give a c.w. output at a convenient level below +7 dBm (1 V e.m.f.).
 - (2) Tune the instrument through its r.f. range and check that the amplitude of any harmonic is greater than 30 dB down on the fundamental for carrier frequencies from 80 kHz to 520 MHz, and 20 dB down on carrier frequencies 520 MHz to 1040 MHz (2019).

Reverse power protection

Test equipment: items e, Multimeter
o, Variable d.c. power supply

- 27. Set the d.c. power supply to +5 V and apply this to the 2018 RF OUTPUT 50 Ω socket causing the RPP circuit to trip.
 - (1) An indication that the REV PWR LIMIT has been exceeded is given in the RF LEVEL display window, a further indication of trip is given by the RF LEVEL function keys integral 1.e.d. This will continually flash until the reset is operated.
 - (2) Remove the +5 V source and check that there is no continuity between the 'N' type connector centre pin and earth (taking care not to damage the connector pin).
 - (3) Reset the RPP by pressing the RF LEVEL key and ensure that both trip indications are turned off. Set the d.c. power supply to -5 V and apply this again to the RF OUTPUT 50 Ω socket checking that the RPP once more trips. Remove the d.c. source and reset the RPP.

FAULT LOCATION

Introduction

- 28. The following section consists of fault finding procedures, charts and tests to aid identifying faults. To assist with fault finding it is advisable to study the description of the overall instrument contained in Chap. 4. The functions of the various boards are generally well defined and independent of each other as far as possible and the parameters of the signals exchanged between them are not critical. All boards/modules are interconnected by a variety of connectors. A useful method of confirming if board or module is faulty is to substitute the unit with a unit that is known to be good (e.g. from a spare working instrument). This can save considerable fault finding time.
- 29. When disconnecting an r.f. connection between two units ensure that the metal clad connector cannot accidentally cause short circuits on the printed boards and create additional faults. If any of the ribbon cable connectors are unplugged ensure that when they are reconnected they are correctly posi-

tioned since the connectors do not incorporate polarizing plugs.

- 30. If any rectification work is carried out in areas containing chip components certain precautions should be taken. Always use solder containing 2% silver and use a high wattage temperature controlled soldering iron set to 315°C (600°F). The temperature controller should preferably directly sense and control the temperature of the soldering iron bit. The soldering iron tip should also be earthed in order to avoid potential damage to static sensitive devices. The chip resistors used in areas other than the 10 dB step attenuator have nickel barrier terminations and are virtually immune to termination leaking problems. The ceramic chip capacitors used have palladium silver terminations that can dissolve or weaken in molten solder. If there is any possibility that a termination has been weakened during rectification work the suspect device should be replaced.
- 31. A useful technique for checking the soundness of chip capacitor terminations is to set the carrier frequency as low as applicable to the relevant circuit and then GENTLY tap the printed board (not the chip component) with a blunt non-metallic object (e.g. the handle of a screwdriver) checking the circuit for any intermittent level changes. Chip components can be mechanically damaged by rough handling or excessive flexing of the printed boards.

Use of second function 3

- 32. Second function 3 can be used as a diagnostic aid under certain circumstances. Its use requires that the microprocessor system and the keyboard is working normally. Second function 3 may then be used to send data to any specified latch. This will enable the operator to establish that the correct data is arriving at the input to the latch by using a storage oscilloscope triggered from the clock input of the latch and observing the data at the latch input as the latch is clocked. Each latch is identified on the circuit diagram by a data valid line and an address e.g. on AC5 the address of the D-A converter, IC4, is given as A7LO. The data valid line is 7 and the latch address is 00 (2 digits are required LO implies 00, L1 implies 01 etc.). Data can be sent to this latch by pressing the keys "SECOND FUNCT", "3", followed by the data valid line "7" and the latch address "0", "0", (2 digits). The data valid line will be displayed in the modulation display and the address is displayed in the r.f. level display. This is followed by entering a string eight binary digits (1's and 0's) corresponding to the data to be sent. Pressing the store key will cause the microprocessor to send the data to the specified latch. If the data that is being send needs to be sent again pressing the STORE key again will send the same data. If the data is to be modified this can be accomplished by entering a new string of data and then pressing the STORE key again.
- 33. Where data is to be sent to the 10 bit D-A type AD7522 the data has to be sent in two bytes. The least significant eight digits are sent first to one latch address (as specified in the control data information, this is stored in a buffer (inside the D-A chip). A new latch address is then entered corresponding to the most significant bits, followed by the required binary data. On pressing the STORE key this data is sent to the D-A and the D-A in turn is set to data specified by the whole 10 bit number. Any data sent via second function 3 remains in the receiving latch until one of the orange function keys is pressed. The microprocessor will then overwrite any data sent and restore the instrument to normal operation.

Maintenance kit

- 34. The maintenance kit contains the following items which may be used for fault finding and servicing.
 - (1) RF lead part number 43129-835R. A 20 cm long SMC female to SMC male connector assembly. Intended to be used when the upper r.f. box is raised for servicing. This lead enables the operator to reconnect the free end of the semi-rigid cable assembly PLAV to PLAX (which connects the synthesizer output from the upper r.f. box to the lower r.f. box) to SKAV in the upper r.f. box.
 - (2) RF lead part number 43129-834C. A 70 cm SMC to BNC lead to enable the output from SMC connectors to be monitored.
 - (3) RF lead part number 43129-836B. A 70 cm SMB to BNC lead to enable the output from SMB connectors to be monitored.
 - (4) Connector assembly part number 54129-833M. A 70 cm crimp to BNC lead to enable the output from a p.c.b. to be monitored where the output is on .025 in square wrap posts.
 - (5) Adapter part number 44828-753H. A 50 to 200 Ω adapter which can be used in conjunction with 43129-833 to monitor a 200 Ω output from a board on .025 in square wrap posts. The adapter introduces a 12 dB insertion loss.
 - (6) 3.7 in 1.c.d. extraction tool part number 46883-531V.
 - (7) 4.7 in 1.c.d. extraction tool part number 46883-530G.
 - (8) LCD insertion tool part number 46883-529S.

FAULT FINDING TO BOARD LEVEL

- 35. The following section describes fault finding routines and algorithms which may be used to help diagnose faults down to board level. The fault finding routines start from a generalized fault condition and guide the operator to the most likely area of the fault. The generalized fault conditions used as a starting point are as follows:
 - (a) Front panel failure.
 - (b) Output frequency error.
 - (c) Output r.f. level error.
 - (d) Carrier harmonic problem.
 - (e) AM fault.
 - (f) FM fault.
 - (g) Residual f.m. problems.
 - (h) RPP failure.

Choose the description that most closely describes the fault condition and use the fault finding guide to establish the area of the fault. Before using the fault finding tables read the notes that accompany the tables.

Front panel failure

36. A chart to aid fault finding a front panel failure is given in Table 5. A front panel failure is defined as a fault in which the keyboard or the display is not operating correctly. One of the first objectives is to establish if the display or keyboard is causing the fault or whether the microprocessor system is not operating. If the microprocessor system is functioning but has a memory fault an error message will be displayed. The error message will appear as the letter P in the modulation display if there is a PROM error, a letter H if it is a RAM error, or a letter L if an EAROM check sum is invalid. In the event of a microprocessor failure in which the microprocessor cannot run the check sum no error message will be displayed. In this case testing to see if the microprocessor board is waiting for a keyboard press should indicate if the microprocessor program is running.

panel displays _____ NO ome on? Check fuses, check power supply AE1 and connections to the front panel boards AD1, AD4, AD2. YES- Is an error message ____ NO -being displayed? Fault on AD1 or AD4. Trace back from 1.c.d. segnotes ment or 1.e.d. to r locate fault. s. Fa bd Disconnect PLY, PLAA YES - PLL from AD2. Doe the fault persist?

> Chap. 5 Page 21

Trace back from 1.e.d./1.c.d. key at fault.

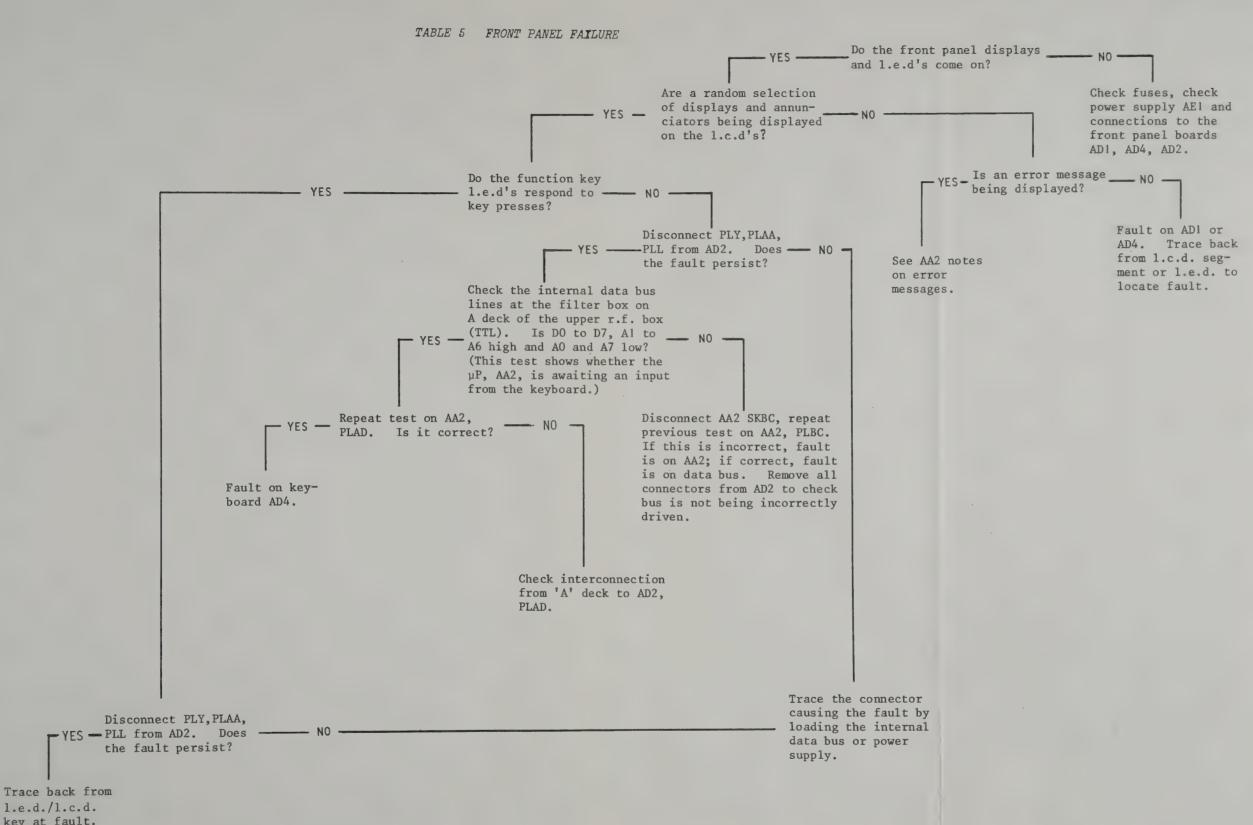
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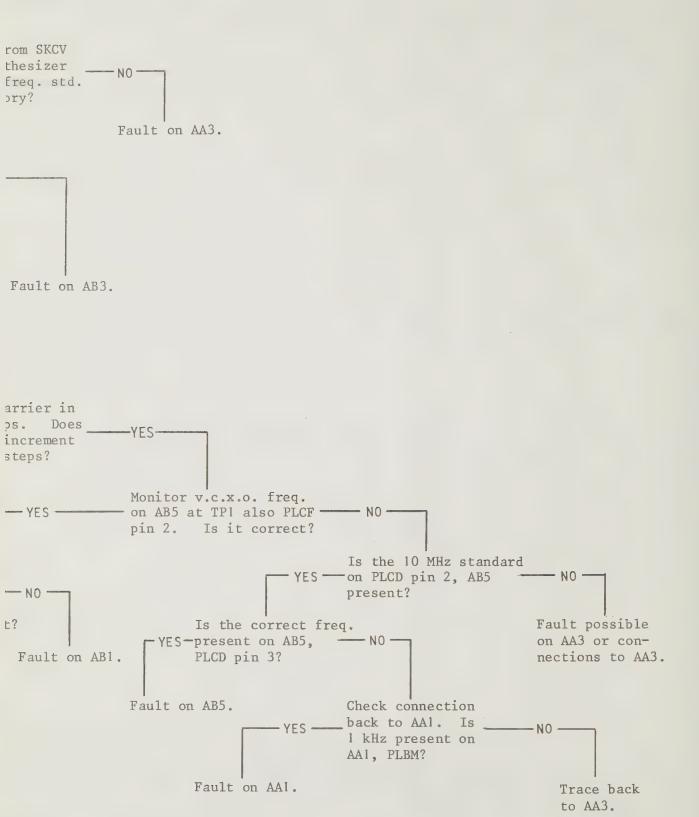
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1.e.d./1.c.d. key at fault.

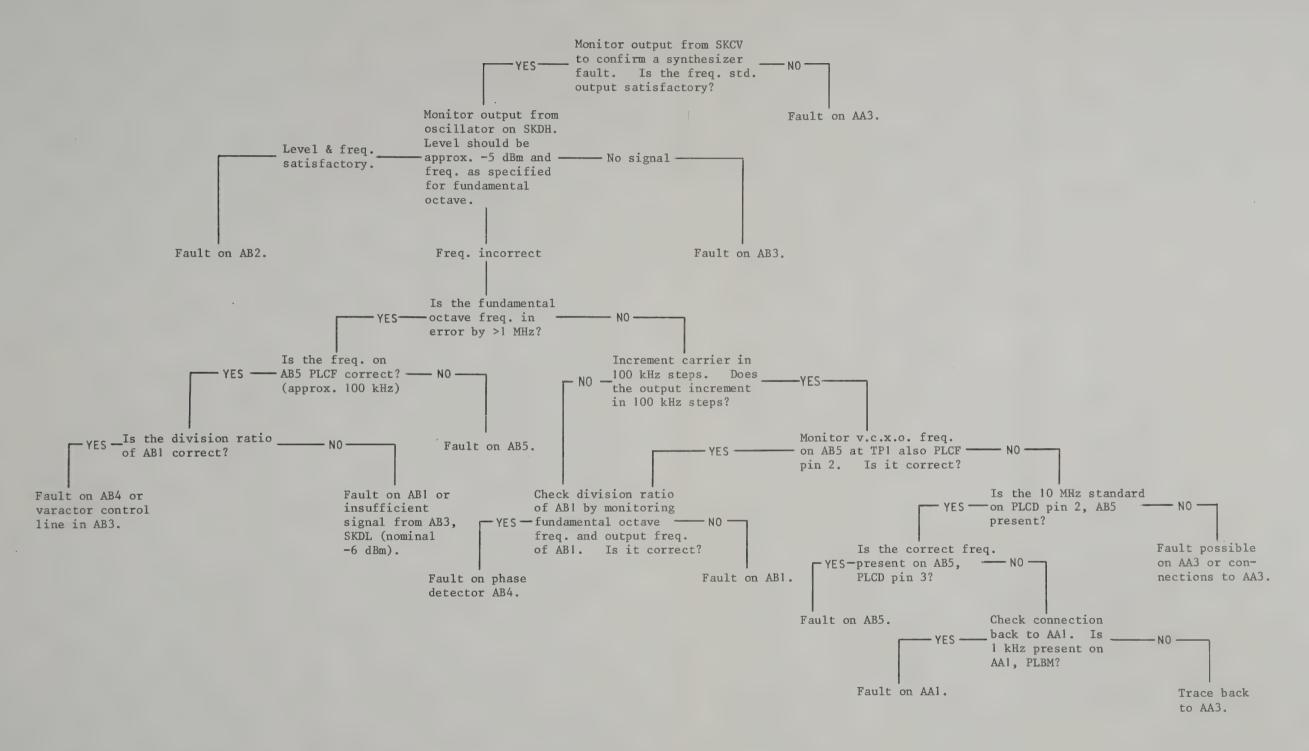
Y ERROR



Output frequency error

- 37. A chart to aid fault finding an output frequency error is given in Table 6. An output frequency error is defined as a fault in which the output carrier frequency, when measured using a frequency counter operating from the same frequency standard as the instrument, indicates that the output frequency differs from the value set.
- 38. If the instrument has been set to operate from an external frequency standard, ensure that an external standard of 10 MHz at 1 V r.m.s. across 50 Ω is applied to the external standard input on the rear panel. Since the output frequency is synthesized in the upper r.f. box any frequency synthesis fault is likely to be in the upper r.f. box with the exception of frequencies below 2.03125 MHz. Faults confined to this b.f.o. band are covered in the section relating to r.f. level faults. For ease of fault finding the r.f. output from the SMC connector, SKAV, at the rear of the upper r.f. box should be used to monitor the output frequency. The output level from this connector should be approximately 0 dBm but its absolute level and flatness is not critical. The waveform is nominally a square wave and so it has a high harmonic content. Certain frequency counters and modulation analysers may be prone to acquiring harmonic frequencies of the output.
- 39. The carrier frequency is synthesized over the frequency range 260 to 520 MHz (the fundamental octave) and then divided down by factors of two. If the fault exists on the fundamental octave it is always easier to locate the fault with the instrument set on this range, since it is easier to calculate the intermediate frequencies used to generate the output. Before starting to fault find, read and understand the description of the synthesizer given in Chap. 4 since it may be necessary to calculate the intermediate frequencies very precisely in order to locate the fault. When dealing with small frequency errors it is advisable to operate the counter measuring the output frequency from the same frequency standard as the instrument.

TABLE 6 OUTPUT FREQUENCY ERROR



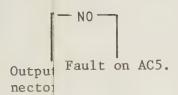
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RF level fault

- 40. A chart to aid fault finding an r.f. level fault is given in Table 7. An r.f. level fault is defined as a failure which results in the r.f. level being out of specification but the carrier frequency is correct and the output signal is not unduly distorted. In assessing if the r.f. level is out of specification the r.f. offset facility should be switched off (second function 7). It is also assumed that the error is such that the instrument does not just require recalibrating.
- 41. The r.f. level accuracy is set up using second function 7. If it is found that the instrument is out of calibration but can be recalibrated using second function 7 it is possible that the fault is due to the EAROM store on AA2 not permanently storing data (see fault finding AA2). Usually (but not always) such faults will also be accompanied by f.m. tracking faults and failure to store instrument settings, r.f. level units or GPIB address. RF level errors are only likely to originate in the lower r.f. box, the attenuator module, or the associated control systems and connectors. The lower r.f. box derives its input from the upper r.f. box via SKAW as a nominal 0 dBm square wave. Because the Amplitude Modulator AC5 acts as a signal limiter the input level to AC5 is not critical.
- 42. For carrier frequencies above 32.5 MHz the square wave output from AC5 is routed through a low-pass filter bank on AC3/13. The filters convert the signal into a sine wave at SKCS of AC3/13. Frequencies above 520 MHz are generated by a frequency doubler on AC13 (2019 only) and also appear on SKCS of AC13. The signal then goes to AC4 via PLCS and is amplified by a variable gain amplifier before going onto the output stages of AC4. RF level faults which are confined to frequencies above 32.5 MHz are most likely to arise because of faults in the filters of AC3/13 or the r.f. amplifiers on AC4.
- 43. Frequencies below 32.5 MHz are routed through a bank of low-pass filters on AC3/13. If the output frequency is above 2.03125 MHz it is then routed to AC2 via PLCT and then to a variable gain amplifier on AC4. If the required output frequency is below 2.03125 MHz a 10 MHz to 12.03125 MHz signal is routed to AC2 via PLCW in order to be mixed with 10 MHz to produce the low frequency signal. RF level faults which are confined to frequencies below 32.5 MHz can therefore originate anywhere along this signal path. It should be noted that much of this low frequency signal path is operating in a 200 Ω system and not the more usual 50 Ω system. For this reason when using a 500 Ω probe to fault find along the signal path some allowance must be made for the loading effects of the probe. If it is required to monitor the output from PLCT of AC3/13 with a 50 Ω spectrum analyser or modulation meter with SKCT disconnected then a series 150 Ω resistor should be used (at the SKCT end) to convert the load into 200 Ω and due allowance made for the resulting insertion loss of 12 dB.
 - 44. RF level faults can be caused if the amplifier system has too much or too little gain and the a.l.c. is therefore unable to control the signal level correctly. The 2018 has been designed to have a considerable gain margin and a typical instrument will have a margin of 8 dB at its worst frequency. The gain margin can be checked if necessary by first setting the output level to 7 dBm and then shorting the junction of R44 and R45 of AC5 to ground using a screwdriver or similar implement. The output level should rise by at least 3 dB (typically a minimum of 8 dB). The signal chain can then be tested for having too much gain by setting the output level to -2.9 dBm and then shorting the junction of R87 and R90 on AC4 to ground. The output level should fall by at least 4 dB.

Fault in output from AB2.



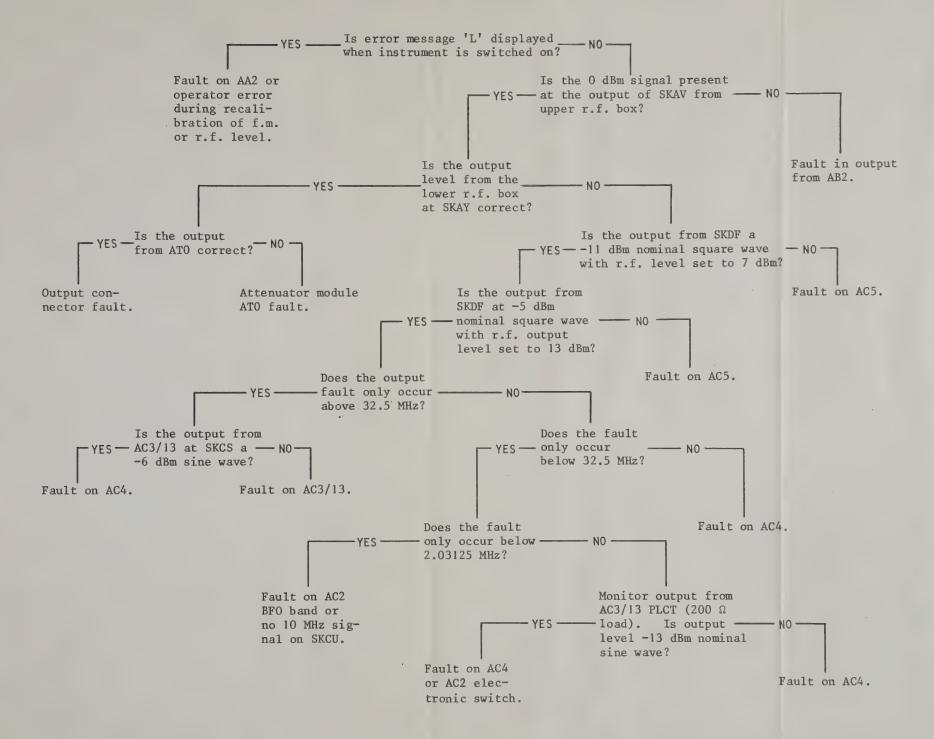
Fault

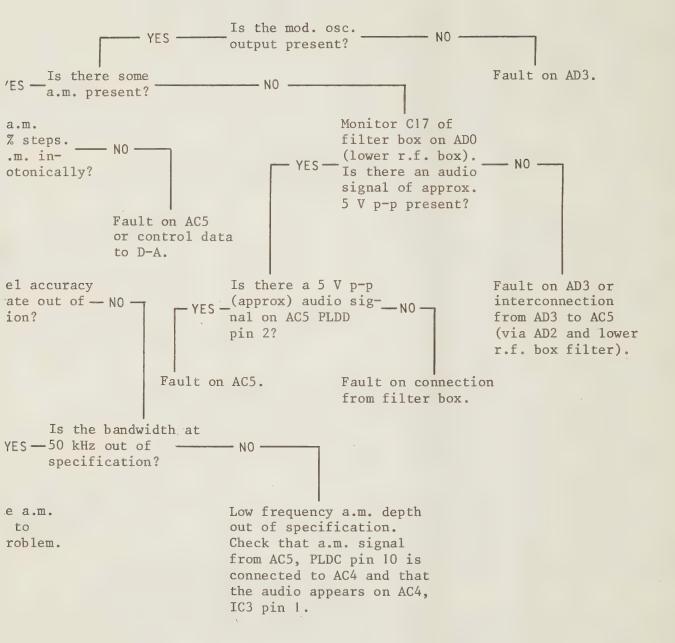
Fault on AC4.

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TABLE ? RF LEVEL FAULT



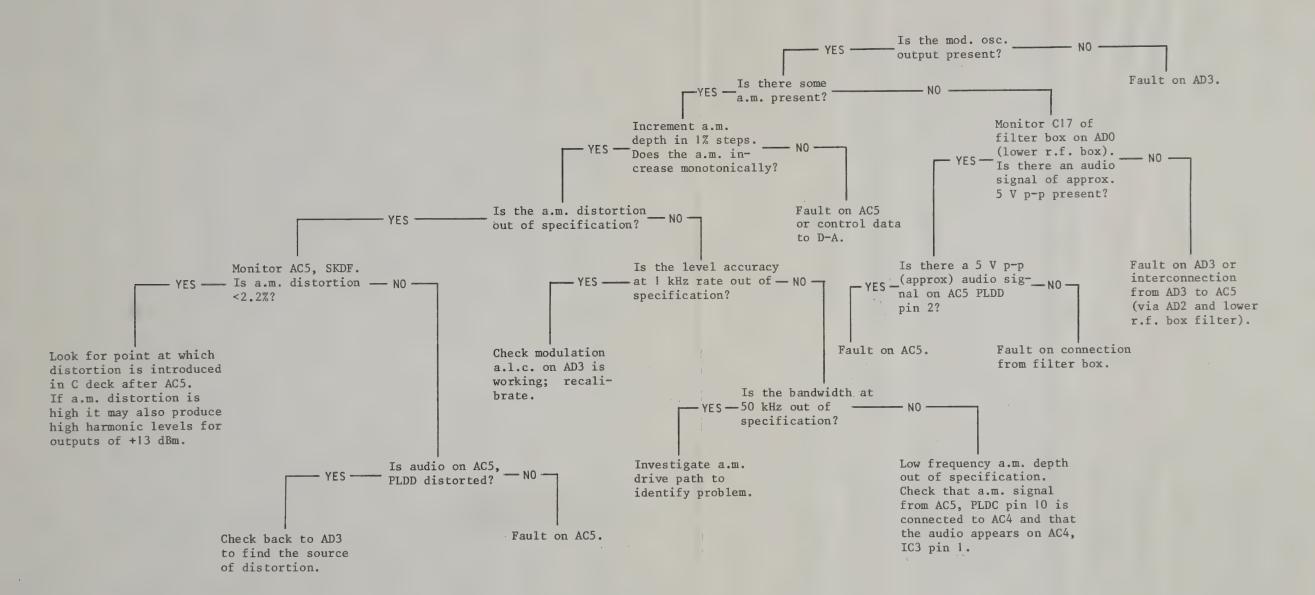


Harmonic distortion fault

- 45. Investigating harmonic distortion faults is usually a straightforward problem so a fault finding algorithm has not been provided. Until the signal arrives on AC3/13 its harmonic content has little effect on the performance of the instrument. On AC3/13 the nominal square wave is filtered by a bank of low-pass filters which converts the signal into a sine wave.
- 46. For problems above 32.5 MHz monitor the nominal -6 dBm signal from SKCS of AC3/13. If the harmonic content is high the fault is on AC3/13. If the harmonics are -40 dBc or better the fault is on AC4. For problems below 32.5 MHz trace the signal path from the filters on AC3/13 to AC2 and AC4 and identify where the harmonic problems start. Much of the low frequency channel operates in a 200 Ω transmission system so care must be taken not to load the system with less than 500 Ω when probing the signal path.

AM fault

- 47. An a.m. fault finding algorithm is given in Table 8. It is assumed that the output frequency is correct and the r.f. level accuracy and harmonic distortion is in specification. The fault finding algorithm first establishes if the fault is inside the lower r.f. box or is on AD2 or AD3.
- 48. When monitoring the output from SKDF AC5 it should be remembered that the output signal is a square wave and the modulation meter used must be capable of rejecting the high level of carrier harmonics present. If the modulation meter is automatically tuned care should be taken to ensure that the instrument tunes to the fundamental and not a harmonic.



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FM fault

- 49. An f.m. fault finding algorithm is given in Table 10. The f.m. drive system is complicated by the requirement to provide f.m. tracking and range scaling to account for the division or multiplication by two of the fundamental octabe as well as providing fine control of the deviation. Most of the algorithm is therefore devoted to identifying which part of the control system is at fault.
- 50. Information on the use of second function 8 is given in the calibration section. In addition second function 3 can be used to check that the various digital to analogue converters are working. A digital a.c. voltmeter can be used to check the input and output levels of a D-A converter and hence establish if the gain of the converter is correct. If the divide-by-two system dividing the f.m. deviation is at fault it should be remembered that the division is accomplished using a divide-by-four system on AB2 as well as a divide-by-two, IC17, on AD3.
- 51. As an aid to diagnosing a fault in the f.m. tracking store Table 9 gives a list of the carrier frequencies used as f.m. tracking points together with the typical values of f.m. tracking data. Typically instruments will be within approximately 20% of the listed values.

TABLE 9 TYPICAL FM TRACKING DATA

OSC 1		OSC 2		OSC 3		OSC 4	
Frequency	Data	Frequency	Data	Frequency	Data	Frequency	Data
260.00001	164	309.00001	157	368.00001	136	437.00001	113
262.45	182	311.95	166	371.45	142	441.15	118
264.9	186	314.9	180	374.9	150	445.3	125
267.35	183	317.85	178	378.35	150	449.45	125
269.8	187	320.8	182	381.8	151	453.6	127
272.25	189	323.75	183	385.25	150	457.75	127
274.7	189	326.7	183	388.7	150	461.9	127
277.15	189	329.65	182	392.15	145	466.05	123
279.6	189	332.6	174	395.6	142	470.2	123
282.05	187	335.55	169	399.05	142	474.35	117
284.5	182	338.5	171	402.5	134	478.5	117
286.95	183	341.45	167	405.95	131	482.65	112
289.4	180	344.4	157	409.4	131	486.8	113
291.85	178	347.35	159	412.85	125	490.95	110
294.3	175	350.3	155	416.3	125	495.1	107
296.75	175	353.25	150	419.75	123	499.25	107
299.2	175	356.2	151	423.2	121	503.4	106
301.65	175	359.15	150	426.65	121	507.55	106
304.1	176	362.1	152	430.1	121	511.7	106
306.55	175	365.05	155	433.35	121	515.85	109
309	177	368	154	437	121	520.0	108

Fault on AD3. present ng table 3). Check system Is faw find over 1 the fu YES -- and is at all those cies t Check data in f.m. trac table. Check f.m. trac AD3, IC11, D-A is monoton and functioning using to 400 MHz. Second function 3. viation in O Hz to 100 Hz, rom 100 Hz to --- NO steps from Does the e monotonically? Check AD3, IC15 10 bit D-A using Second function 3.

÷2 D-A

rated :4 system.

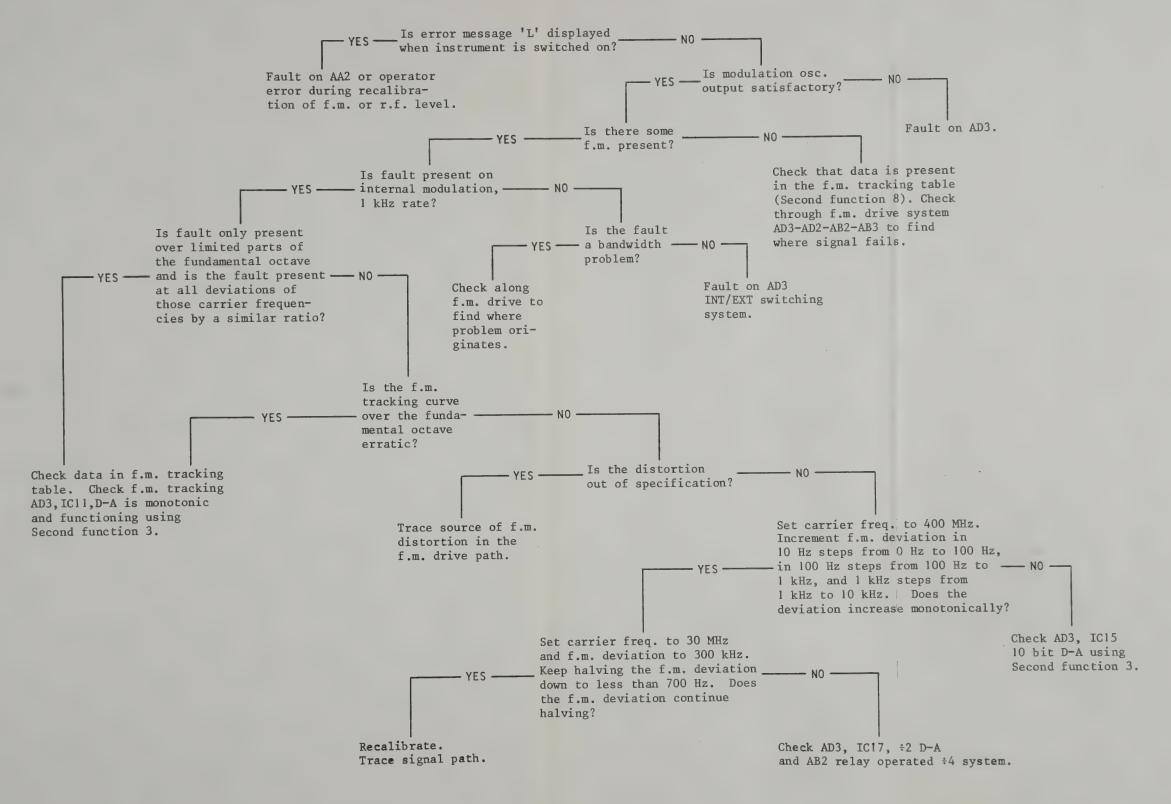
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264.9	186	314.9	180	374.9	150	445.3	125
267.35	183	317.85	178	378.35	150	449.45	125
269.8	187	320.8	182	381.8	151	453.6	127
272.25	189	323.75	183	385.25	150	457.75	127
274.7	189	326.7	183	388.7	150	461.9	127
277.15	189	329.65	182	392.15	145	466.05	123
279.6	189	332.6	174	395.6	142	470.2	123
282.05	187	335.55	169	399.05	142	474.35	117
284.5	182	338.5	171	402.5	134	478.5	117
286.95	183	341.45	167	405.95	131	482.65	112
289.4	180	344.4	157	409.4	131	486.8	113
291.85	178	347.35	159	412.85	125	490.95	110
294.3	175	350.3	155	416.3	125	495.1	107
296.75	175	353.25	150	419.75	123	499.25	107
299.2	175	356.2	151	423.2	121	503.4	106
301.65	175	359.15	150	426.65	121	507.55	106
304.1	176	362.1	152	430.1	121	511.7	106
306.55	175	365.05	155	433.35	121	515.85	109
309	177	368	154	437	121	520.0	108

TABLE 10 FM FAULT





Residual f.m. problems

- 52. This section provides guidance for identifying the source of residual f.m. problems. No fault finding algorithm is provided. Residual f.m. problems are usually the result of spurious modulation of the oscillators in the upper r.f. box. The internal frequency standard should be checked first for spurious modulation. The most sensitive oscillator is the bank of four oscillators on AB3 (only one is in use at any given time) whose varactor diode sensitivity can be up to 10 MHz/V. Even very low level signals can cause spurious signals.
- 53. If the spurious signal is related to the mains frequency check that the d.c. power supplies do not have high levels of ripple. Typically the +5 V supply has 100 μ V of 100 Hz (or 120 Hz) and the +15, -15 and +24 V supplies have 30 μ V or less. Check that the regulators on AB4 (+11.5 and -11.2) are within 12% of their nominal value. Check that the +5 V regulator IC1 on AA0 is operating correctly.
- 54. Instability in a phase locked loop can cause coherent spurious signals to be generated. This can be checked by observing the varactor diode voltages on AAI, AB5 and AB4 with an a.c. coupled oscilloscope and checking for coherent signals. Phase locked loop instability will normally produce significant signal excursions while maintaining the average frequency of the loop at the correct frequency. It should be noted that the input to the oscilloscope must be a.c. coupled since the loading of even quite high impedances (10 M Ω) can result in the phase detector having to produce a significant output at the phase detector rate.
- 55. The output phase locked loop can be made unstable in the f.m. off mode if the loop filter control lines on AB4 and AB3 are not operating correctly. A similar problem can exist in the f.m. on mode but normally one of the modes will operate if the fault is due to the loop filter control lines. Phase locked loop instability, where the average output frequency is correct, but the frequency is very unstable, is most likely to be caused by faulty components in the analogue part of the phase detector where the output current pulses are directed to the loop filter and the resulting d.c. is fed to the varactor diodes.
- 56. If the amount of residual f.m. is small (though not out of specification) and no obvious fault can be found the problem may originate in AB3. More fault finding data for AB3 is given in the board level fault finding section.

RPP failure

- 57. The RPP system uses a reed to protect the output of the attenuator from the accidental application of reverse power (d.c. or r.f. power). The RPP can be tested by applying ±5 V d.c. to the r.f. output connector. If the 1.e.d. in the RF LEVEL key flashes and the REV PWR LIMIT annunciator is set but the RPP delay does not go open circuit, first check to see if the yellow 1.e.d. D10, on AT2 is on. If it is on this indicates that although the detector has alerted the keyboard the RPP delay has been left on and the fault is on AT2. If D10, AT2 is not on check that the voltage on C1, AT0 is at approximately 0 V. If it is, relay assembly RLF, AT1 has been damaged.
- 58. If applying ±5 V to the r.f. output fails to produce a front panel response and the RPP relay remains closed check that approximately 0.75 V is present on C2, ATO if +5 V has been applied, or that -0.75 V appears on C3,

- ATO if -5 V is applied. If this voltage is not present the fault is on ATI and if the voltage is present the fault is on AT2.
- 59. If the front panel does not respond but the RPP relay is open circuit this will indicate that the control line from AT2 to the keyboard AD4 is not operating the electronic switch on AD4 and the fault can be traced from AT2 to AD4 via AD2.
- 60. If the front panel responds as soon as the instrument is switched on and without reverse power being applied, this indicates that there is a fault in the detector system on ATO or the RPP is not being reset when the instrument is switched on. The RPP reset line can be traced using second function 3. It should be noted that if AD3 is not plugged into its edge connector, the RPP will not be reset because the attenuator address latch (A6L10) is decoded on AD3.

BOARD LEVEL FAULT FINDING

61. The following section gives guidance on fault finding at board level. Where appropriate, guidance is given on how to fault find on the printed board; the control data generated by the microprocessor; information on the waveforms that can be expected at various points on the circuit, and how to realign the board before recalibrating the instrument.

AA1 : LSD loop

- 62. AAI includes a complete phase locked loop and an additional variable ratio divider (VRD). Phase locked loop faults can be traced by checking each element in the system i.e., the oscillator, the VRD and the phase detector.
- 63. First check that the oscillator is working (not necessarily at the correct frequency) by monitoring TPl. In a functioning loop, its frequency will be between 10 and 19.999 MHz. A fault elsewhere on the board may result in the frequency being incorrect in which case the voltage on TP2 should be checked to see if it is giving the expected varactor voltage for the observed oscillator frequency. If the frequency on TP1 is correct the fault will be the VRD formed by IC10 IC17 and fault finding can be carried out in the same way as when fault finding on the phase locked loop's VRD.
- 64. If the oscillator is functioning correctly but is not at the correct frequency, check the division ratio of the VRD by measuring its input and output frequency and calculating the ratio. If the VRD is at fault check that the data latched by IC8 and IC9 is correct. If no fault is found check that each of the counters IC3 to 7 have clock input pulses on pin 2 and that the QA and QD outputs (pins 14 and 11) have pulses which reduce in frequency by factors of approximately 10 as the signal progresses down the counter chain. Failure of a device to produce these pulses would indicate that either the RESET line is low (fault IC16) the relevant IC is faulty or there is a fault with the carry out pulse from pin 15 of the previous counter IC.
- 65. If the VRD is not at fault check the phase detector circuit for faults. As a further aid to fault finding the mini-jump linking TP3,4 may be removed and a variable positive voltage applied to TP4 in order to directly control the oscillator frequency. If the oscillator frequency (on TP1) is adjusted just above the correct frequency, TP2 should be pulled down to 0.2 V by the phase detector. If the frequency is pulled too low then TP2 should be driven to 14.8 V by the phase detector.

66. Control data AAI. To calculate the control data for AAI first calculate the carrier frequency generated by AB3 using the block diagram. This will equal the output frequency if it is between 260.00001 MHz and 520 MHz. Consider the frequency to be ABC.DEFGH MHz. Data sent is then as shown in Table 11 below.

TABLE 11 CONTROL DATA AA1

Latch	IC	Data	Data
address	numbers	Lines	
A6L0	IC11	D0-D3	Second m.s.b. of (10000 - ABCD) m.s.b. of (10000 - ABCD)
A6L1	IC10	D0-D3	1.s.b. of (10000 - ABCD)
	IC10	D4-D7	Second 1.s.b. of (10000 - ABCD)
A6L2	IC9	D0-D3	Nines complement of F
	IC9	D4-D7	Nines complement of E
A6L2	IC9	D0-D3	Nines complement of F
	IC8	D4-D7	Nines complement of G

67. Test data AAl.

- Output from 1.s.d. oscillator. Frequency between TP1 10 and 20 MHz. Waveform amplitude is typically 5 V p-p at 10 MHz and 4 V p-p at 19.999 MHz.
- TP2 Varactor voltage for 1.s.d. oscillator. DC level 2.28 V at 10 MHz, 10.1 V at 19.999 MHz.
- TP3.4 Mini jump may be removed and a d.c. voltage applied to TP4 to control the 1.s.d. oscillator while fault finding.
- Used by Marconi Instruments Autotest only. TP5,6,7,8
- Normally high with a 50 ns pulse to low state with IC16, pin 9 a p.r.f. of 1 kHz if the 1.s.d. loop is working. An additional very narrow pulse may be present 400 to 800 ns previous to this pulse - this is not a fault.
- Pulse waveform with p.r.f. of 1 kHz. Mark to space IC7, pin 14 ratio is variable, being low for 100 ns when the 1.s.d. is at 10 MHz and approximately a square wave.
- IC1, pin 11 Pulse waveform | kHz p.r.f.
- When phase locked normally high with low 60 ns pulses IC1, pin 5 at a p.r.f. of 1 kHz. If 1.s.d. loop oscillator frequency is high (not phase locked) it should produce wider pulses to try to pull the oscillator frequency lower.
- When phase locked normally low with high 50 ns pulses IC1, pin 8 at p.r.f. 1 kHz. If the 1.s.d. loop oscillator frequency is low (not phase locked) it should produce wider pulses to try to pull the oscillator frequency higher.

AA2: Microprocessor system

- 68. The board AA2 contains the microprocessor controller and an interconnection system for distributing control data. All the complex IC's on this board are plugged into IC sockets in order to aid fault finding. Without these sockets fault finding can be difficult because of the complex nature of the operations undertaken on this board. If the error message "H" is displayed at switch—on this indicates a RAM fault in either IC3 or IC7. If the error message "P" is displayed at switch—on this indicates a fault in the PROM set IC13,14,15 or 16. This set of IC's is normally replaced as a set. Faulty IC sockets, breaks or shorts in tracks may also lead to error messages being displayed if they result in the RAM/PROM being incorrectly read. If error message "L" is displayed the calibration data in the EAROM store has changed and does not agree with the check sum. This would indicate a faulty EAROM or that the -30 V supply is being incorrectly switched during switch—on or off.
- 69. Failure to display an error message does not eliminate RAM or PROM faults if the microprocessor is unable to run the system. If no obvious fault can be found (e.g. IC's running hot) first check that there is a clock signal on ICl pin 7. If there is not check for loading effects by removing the minijump from TP7,8 and then try replacing ICl and XLl. If no fault can be found try replacing each IC in turn until the cause can be found.
- 70. Faults confined to the EAROM store should be investigated by first checking that the -30 V supply to the EAROM, IC8, is operated during a store operation. Also check that at switch-on and switch-off the -30 V line is not turned on. If these tests are satisfactory replace IC8 and re-calibrate the instrument. The replacement EAROM will have to be initialized as described in the calibration section.

71. Test data AA2.

- IC1, pin 37 Microprocessor clock 3.072 MHz.
- IC7, pin 35 Normally low. When completing a store operation it should go intermittently high (and sometimes tri-state) in order to turn on the -30 V supply to IC8.
- IC9, pin 12 Normally at -15 V. When completing a store operation it should oscillate between -15 V and ground.
- IC9, pin 2 Normally at 0 V. On completing a store operation it should oscillate between 0 and -15 V.
- TR5 collector Normally at 0 V. When completing a store operation it should oscillate between +5 and -15 V.
- TR4 emitter Normally at -15 V. When completing a store operation it falls to -30 V.
- IC8, pin 1 Normally at +5 V. On completing a store operation it falls to -30 V intermittently.

AA3: Frequency standard

72. Control data AA3. The control data for AA3 is latched on AA2 as shown in Table 12 below.

TABLE 12 CONTROL DATA AA3

Latch address and data line	PLBP pin no.	Data
A6L5 D4	5	Logic high if INT STD. low if EXT STD.
A6L5 D6	10	Logic high if output frequency is >2.03125 MHz.

73. Test data AA3.

IC1, pin 4 On INT STD 3 V p-p 10 MHz standard. On EXT STD logic low. High for INT STD. IC1, pin 5 Low for EXT STD. IC2, pin 10 On INT STD t.t.1. level 10 MHz signal. On EXT STD logic low. IC3, pin 3 TTL level 10 MHz signal. IC3, pin 9 TTL level 100 kHz signal. IC4, pin 9 TTL level 1 kHz signal. IC2, pin 4 For carrier frequencies from 2.03126 MHz logic low. For carrier frequencies up to 2.03125 MHz t.t.1. level 10 MHz signal. R8, R9 junction Nominal sine wave 0.6 V p-p. PLBP, pin 14 Nominal sine wave 0.6 V p-p with spurious amplitude modulation caused by the v.c.x.o. frequency on AB5.

AB1 : Output v.r.d.

74. If a fault on AB1 has been diagnosed first check that the r.f. voltage on the collector of TR1 is correct. If the fault results in there being no output from PLBU this normally indicates a catastrophic failure of one of the components in the divider chain. Use an oscilloscope to check that there is a clock pulse on TP1. If there is not this indicates a fault in one of the dividers IC1, IC2 or the buffer stage IC3a. Then use the oscilloscope to check that the QA and QD outputs of IC7,8,9 are toggling. If none are toggling check that TP3 is generally high. If it is not, this indicates a fault in the subsidiary counter system formed by IC11,12. If TP3 is high and none of the IC's toggle the fault is likely to be in IC7.

- 75. If the VRD is functioning and the division ratio is controllable (though the ratio is wrong) check that the correct data has been latched on IC4,5. If the incorrect division ratio seems to be related to one decade of the division ratio only, replace the respective counter (IC6 for 100 kHz decade, IC7 for 1 MHz decade, IC8 for 10 MHz decade and IC9 for 100 MHz decade of the fundamental frequency). When the 100 kHz decade (IC6) is suspected it is possible that a fault exists in the 10 or 11 divider, IC2, or its associated control circuit.
- 76. If the VRD produces an output signal but the division ratio is not controllable this indicates a fault in one of the devices that reset the counter chain. Check that all the inputs to IC12 are toggling and that periodically there is an output pulse on TP4 which enables the subsidiary counter IC11.
- 77. Control data AB1. AB1 uses two latch addresses to recieve control data. These addresses are identical with two addresses on AA1. As with AA1 assume the output frequency from AB3 is of the form ABC.DEFGH MHz where ABCD is between 2600 and 5200. The data sent to AB1 is then as shown in Table 13 below.

TABLE 13 CONTROL DATA AB1

Address	IC No.	Data lines	Data
A6L0	IC5	D4 - D7 D0 - D3	MSB of (10000 - ABCD) Second m.s.b. of (10000 - ABCD)
A6L1	IC4	D4 - D7	Third m.s.b. of (10000 - ABCD) LSB of (10000 - ABCD)

78. Test data ABI.

TR1 collector 0 dBm signal at fundamental frequency. TP1 TTL level signal. Frequency approx. 13 to 26 MHz according to fundamental frequency set. TP2 TTL level. Normally high with a low pulse of between 0 ns (non existent) and 750 ns according to the fundamental frequency set and the setting of the 1.s.d. (100 kHz decade of fundamental freq.) of VRD setting. TP3 TTL level. Normally high with low pulse of 75 ns to 150 ns duration according to fundamental frequency setting. TP4 TTL level. Normally low with two high pulses close together. The first and only significant pulse is between 40 ns and 80 ns wide according to the fundamental frequency. Frequency is approximately 50 kHz. TP5 For Marconi Instruments Autotest use. IC9, pin 12 Output from VRD. Frequency approx. TTL level. 50 kHz.

AB2: Divide-by-two chain and f.m. drive

79. The r.f. divide-by-two system on AB2 is generally straightforward. A fault will normally result in a failure to frequency divide the signal over one or more octaves and either produce the wrong output frequency or no output at all. The fault will normally be found in the highest frequency circuit that fails to operate correctly. Check that when the fault occurs the data latched by IC8 is correct and check the input and output circuits of the divide-by-two that normally generates the required octave of frequency. The relevant dividers are listed below:

Output frequency range	Output IC No.
260-520 MHz	***
130-260 MHz	1
65-130 MHz	2
32.5-65 MHz	3
16.25-32.5 MHz	4
8.125-32.5 MHz	4
4.0625-8.125 MHz	5
2.03125-4.0625 MHz	5

If all frequencies below 130 MHz are affected, check that IC6 is not faulty.

80. Control data AB2. Two sets of control data are required for AB2. The data sent to the octal latch IC8 control the circuits that divide the output from AB2 by factors of two as shown in Table 14 below.

TABLE 14 DIVIDE-BY-TWO CONTROL DATA AB2

Output frequency	Date	r sen	t to	latch	A6L4	IC8	of	AB2
of instrument (MHz)		D6				D2		
1040 - 520.00002	1	1	0	0	0	1	1	1
520 - 260.00001	Amen	1	0	0	0	1	1	1
260 - 130.00001	1	0	1	0	0	. 1	1	1
130 - 65.00001	1	0	0	1	0	1	1	1
65 - 32.50001	1	0	0	0	0	0	1	1
32.5 - 16.25001	1	0	0	0	0	1	0	0
16.25 - 8.12501	1	0	0	0	1	1	0	0
8.125 - 4.06251	1	0	0	0	1	1	0	1
4.0625 - 2.03126	1	0	0	0	1	1	1	1
0.08 - 2.03125	1	0	0	0	1	1	0	0

81. The second set of control data is required to provide range data for the f.m. drive circuits. From the f.m. deviation the instrument is set to first calculate the f.m. deviation required from AB3. This calculated deviation has to take into account the fact that if AB2 has to be set to

divide the frequency from AB3 then it will also divide the f.m. deviation. The frequency multiplier in 2019 that generates the 520 to 1040 MHz band doubles the f.m. deviation and the b.f.o. band of 0.08 - 2.03125 MHz is generated from 10 to 12 MHz. From this deviation, called the fundamental deviation, the control data required is as shown in Table 15 below.

TABLE 15 RANGE CONTROL DATA AB2

Fundamental deviation (kHz)	Da: D7	ta s ei D6				of AB		D0
1280 - 5200	*	*	*	*	*	1	1	1
320 - 1280	*	*	*	*	*	1	1	0
80 - 320	*	*	*	*	*	1	0	0
0 - 80	*	*	*	*	*	0	0	0

Note * indicates a "don't care" state.

82. Test data AB2.

TR1 collector	Approximately 0 dBm at fundamental frequency.
TR2 emitter	For output freq. >260 MHz signal level -14 dBm. For output freq. <260 MHz signal level 0 dBm with some sub-harmonics present.
IC1, pin 7	For output freq. >130 MHz signal level less than -20 dBm. For output freq. <130 MHz signal level 0 dBm covering octave 130 MHz to 260 MHz. Some subharmonics present.
TR8 base	For output freq. <130 MHz signals are at -15 dBm. For output freq. 130 to 260 MHz signal -5 dBm. For output freq. >260 MHz only low level signals.
PLCJ, pin 2	With carrier frequency 520 MHz, f.m. deviation 5.2 MHz at 1 kHz rate. Audio signal typically 8 V p-p. As above at 2.6 MHz deviation audio signal 4 V p-p. As above at 1.2 MHz deviation audio signal 7.7 V p-p.

AB3 : RF oscillators

- 83. Faults on AB3 which result in one or more of the oscillators not operating can generally be found by first identifying which oscillator is at fault and then checking the d.c. bias conditions of the active and off oscillators. If the active device is not at fault it will be necessary to check or replace each element of the tuned circuit.
- 84. Residual f.m. problems are generally more difficult to find. There are many possible causes but the most likely ones are noisy varactors, noisy transistors or intermittent capacitors. The decoupling capacitors C9,C10,C25,C26 can cause residual f.m. problems even when the oscillator to which they are connected is not on. This is because they cause an additional coupling diode,

- D3, D4, D10 or D11 to be partially turned on.
- 85. Microphony can be caused if the inductors L1,L2,L5,L6,L7,L8,L11,L12 are not securely varnished to the printed circuit board.

86. Test data AB3

SKDL (Output from pin 1). Output level varies from

approximately -3 dBm to 2 dBm according to fundamental frequency selected. Frequency is that of the funda-

mental octave.

C112 (Input from pin 1). Between 3 V and 15 V according

to the frequency selected.

TR6 base Approximately 6 dBm varying with fundamental octave

frequency.

TRII collector Approximately -3 dBm. May have significant levels

of harmonics present.

87. The following data applies with a carrier frequency of 520 MHz set:

TR2 collector 11.5 V d.c.

TR4 collector 11.5 V d.c.

TR7 collector 11.5 V d.c.

TR9 collector 8.5 V d.c.

- 88. Realignment data AB3. Each of the 4 oscillators incorporates a sliding link on its tuning inductor which may be used to set up the oscillator. During adjustment the heat of the soldering iron used to move the link will cause some reaction from the oscillator frequency. Excessive heating should be avoided in order to avoid long settling times.
 - (1) On oscillator 1, adjust the sliding link such that at an output frequency of 260.00001 MHz, the voltage on tag 2, is nominally 3.6 V without the lid of the oscillator on.
 - (2) On oscillator 2, adjust the sliding link such that at an output frequency of 309.00001 MHz, the voltage on tag 2, is nominally 3.3 V without the lid of the oscillator on.
 - (3) On oscillator 3, adjust the sliding link such that at an output frequency of 368.00001 MHz, the voltage on tag 2, is nominally 3.3 V without the lid of the oscillator on.
 - (4) On oscillator 4, adjust the sliding link such that at an output frequency of 437.00001 MHz, the voltage on tag 2, is nominally 3.3 V without the lid of the oscillator on.

AB4: Output phase detector

- 89. Digital faults on AB4 are generally easy to find using the test data provided. If necessary the mini-jump linking TP6,7 can be removed and a voltage applied to TP7 to control the oscillators on AB3, but most faults can be found without using this method. Faults in the digital part of the phase comparator are also relatively easy to find.
- 90. If the fault is in the analogue part of the phase detector first check all the d.c. voltages given in the test data. If the fault has not been located, remove the mini-jump and connect 0 V to TP7. IC5, pin 8 should produce pulses which will pull TP7 to 18 V. Check that this happens. If it does not, the fault is in the current pulse generator (TR12 to TR23) part of the phase detector. Repeat the test while applying 15 V to TP7. IC5, pin 6 should generate pulses which pull TP6 down to -8 V.
- 91. Diagnosing which transistor in the current pulse generator is at fault can be time consuming and as a result, it is often quicker to replace all the transistors.
- 92. If the phase locked loop sets the output frequency to approximately the correct value but the frequency is unstable, check that the p.l.l. filter control lines are working. If the fault cannot be found, replace the components in the loop filter. If TR6 develops a drain to source short circuit it may result in TR25 developing excessive input leakage current (because of impact ionization) and cause excessive phase detector breakthrough on the output carrier signal.
- 93. Control data AB4. The control data for AB4 is latched on the microprocessor board AA2. The latch address is A6L5. It should be noted that the latch address A6L5 also controls the frequency standard on AA3.

PLBY Pin No.	Line	Data
3	LD0	High for fundamental frequencies of 260.00001 to 309 MHz.
12	LD1	High for fundamental frequencies of 309.00001 to 368 MHz.
4	LD2	High for fundamental frequencies of 368.00001 to 437 MHz.
11	LD3	High for fundamental frequencies of 437.00001 to 520 MHz.
5 .	LD5	High if f.m. is not on.

If data to latch A6L5 is being sent under second function control ensure that the data sent on D4 and D6 is also correct (see AA3).

94. Test data AB4

IC1, pin 8 TTL signal. Approx. 50 kHz square wave.

IC4, pin 8 TTL signal. FM OFF. Approx. 50 kHz square wave. FM ON. Approx. 10 kHz signal.

TTL signal. If output loop is locked then with f.m. off p.r.f. is approx. 50 kHz, and with the f.m. on it is 10 kHz.

IC5, pin 9

TTL signal. Normally high with a 50 ns low pulse at p.r.f. of approx. 50 kHz (FM OFF) or 10 kHz (FM ON). If the loop is out of lock and the oscillator (AB3) frequency is low, wider pulses should be produced to increase the oscillator frequency.

IC5, pin 6

TTL signal. Normally low with a 50 ns high pulse at a p.r.f. of 50 kHz (FM OFF) or 10 kHz (FM ON). If the loop is out of lock and the oscillator frequency is high, wider pulses will be produced to decrease the oscillator frequency.

TR10 collector With FM ON : 0 V. FM OFF : -11.2 V.

TR9 collector With FM OFF: 0 V.
FM ON: -11.2 V.

TP1 DC level approx. 17.5 V. When locked and the f.m. is off it has a 1 V positive pulse 50 ns wide. With the f.m. on the pulse should disappear.

TP2 DC level approx. -8 V. When locked and the f.m. is off it has a 0.7 V negative pulse 50 ns wide.

No pulse when f.m. is on.

TP3 DC level approx. 17.5 V. When locked it has a 1 V positive pulse 50 ns wide with a p.r.f. of 50 kHz with the f.m. onf and 10 kHz with the f.m. on.

TP4 DC level approx. -8 V. When locked it has a 0.7 V negative pulse 50 ns wide with a p.r.f. of 50 kHz with the f.m. off and 10 kHz with the f.m. on.

TP6,7 Mini-jump may be removed to control the oscillators on AB3 directly by applying a variable d.c. voltage to TP7.

AB5 : Voltage controlled crystal oscillator (v.c.x.o.) loop

- 95. AB5 contains the complete v.c.x.o. phase locked loop. There is a potential latch up condition which can occur only under fault conditions, whereby the phase locked loop can lock to a frequency less than 10 MHz. To avoid any possible confusion it is often easier to fault find with the mini-jump linking TP2,3 removed and the v.c.x.o. frequency controlled by a voltage applied to TP3.
- 96. An unusual fault can be caused if the capacitor C19 is open circuit. The spurious pick-up on pin 7, IC5, can cause multiple transitions on the output of IC6a and result in erratic failure to lock. This fault can be diagnosed by checking the output from IC6a for spurious edges on pulse transitions.

97. Test data AB5.

TR1 collector Distorted 3 V p-p signal. When phase locked frequency is between approx. 10.002 and 10.008 MHz (v.c.x.o. freq.).

TP1 TTL signal. VCXO frequency.

TR8 collector Distorted signal at v.c.x.o. frequency | V p-p.

IC2, pin 1 10 MHz sine wave 0.6 V p-p. Some spurious a.m. from the v.c.x.o. frequency.

IC2, pin 6 DC level 9 V. Audio signal approximately 1.5 V p-p. Frequency (when locked) of approx. 2 to 8 kHz.

IC5, pin 3 Audio signal about ground. Approx. 1.5 V p-p.

IC5, pin 7 Square wave signal 5 V p-p. TTL compatible, freq. approx. 2 to 8 kHz.

IC4, pin 3 TTL signal. Freq. of 2 to 8 kHz.

IC4, pin 11 TTL signal. Freq. 2 to 8 kHz if v.c.x.o. is locked.

IC4, pin 8 TTL signal. Normally low with a 60 ns positive pulse. If the v.c.x.o. frequency is too low it produces wider pulses to pull the v.c.x.o. frequency lower.

IC4, pin 5 TTL signal. Normally high with a negative 60 ns pulse. If the v.c.x.o. frequency is too high it produces wider pulses to pull the v.c.x.o. frequency higher.

With carrier frequency set to 520 MHz (v.c.x.o. approx. 10.002 MHz) d.c. level 3.6 V.
With carrier frequency set to 260.09999 MHz (v.c.x.o. approx. 10.008 MHz) d.c. level 10 V.

TP2,3 Mini-jump may be removed and an external d.c. voltage applied to TP3 to control the v.c.x.o. frequency.

AC2: Beat frequency oscillator (BFO) system

98. Test data AC2. The following data applies at a carrier output frequency of 2 MHz.

PLCU, pin 2 10 MHz square wave 0.6 V p-p.

TRI collector 10 MHz square wave 0.6 V p-p.

PLCV, pin 1 12 MHz sine wave 90 mV p-p.

TR2 collector Very distorted signal approx. 80 mV p-p.

L4,L5 junction -20 dBm 2 MHz signal and 2 V d.c.

PLCW, pin 3 4 V d.c.

PLCW, pin 1 -20 dBm at 2 MHz.

99. The following data applies at an output frequency of 10 MHz.

PLCU, pin 2 0 V.

L4,5 junction No signal.

PLCW, pin 3 +0.05 V d.c. RF signal level -15 dBm.

PLCW, pin 1 RF signal -15 dBm.

AC3/13: Filter and frequency doubler

100. Faults in the filter sections of AC3 or AC13 will usually result in the signal faults occurring over specific half octaves of frequency cover. The half octaves involved will usually give some idea of where the fault is. If the error occurs only at frequencies greater than 32.5 MHz, check the d.c. voltages at the output of IC4 against the test data. These d.c. voltages control the diodes that switch the filters. Faults in the frequency doubler section of AC13 (2019 only) can be difficult to trace because of the high frequencies involved. The recommended procedure is to first establish that the active stages are working (TR4, TR5, TR6). Check that the filter control outputs from IC7 are correct. If the fault is diagnosed as being in the filter circuits it may be necessary to replace the components one at a time, in order to find the fault. It should be noted that the earth end of R112 may be disconnected in order to improve the sub-harmonic content of the output signal at 1.04 GHz.

101. Control data AC3/13

TABLE 16 IC2 CONTROL DATA AC3/13

Output frequency (MHz)	D7	Data s D6	ent t D5			of A		D0	
520.00002 - 1040	1	1	1	1	1	1	1	1	
260.00001 - 520	0	1	1	1	1	1	1	1	
130.00001 - 260	1	0	1	1	1	1	1	1	
65.00001 - 130	1	1	0	1	1	1	1	1	
32.50001 - 65	1	1	1	0	1	1	1	1	
16.25001 - 32.5	1	1	1	1	0	1	1	1	
8.12501 - 16.25	1	1	1	1	1	0	1	1	
4.06251 - 8.125	1	1	1	1	1	1	0	1	
2.03126 - 4.0625	1	1	1	1	1	1	1	0	
0.08 - 2.03125	1	1	1	1	1	0	1	1	

Data line	Data sent to A7L5 IC3 of AC3/13
D4	High for frequencies less than or equal to 520 MHz (2019 only).
D3	High for frequencies of 2.03126 to 1040 MHz.
D2	High for frequencies of 16.25001 to 23 MHz and for frequencies of 260.00001 to 368 MHz, and for frequencies of 32.50001 to 65 MHz.
D1	High for frequencies of 260.00001 to 1040 MHz, 16.25001 to 32.5 MHz and fundamental frequencies of 368.00001 to 520 MHz.
DO .	High for frequencies of 0.08 MHz to 32.5 MHz.

Note: Fundamental frequency is defined as the output frequency from AB3.

TABLE 17 IC6 CONTROL DATA AC13

Output frequency (MHz)	D7		sent D5					D0	
520.00002 - 660	*	*	*	*	1	0	1	0	
660.00002 - 820	*	*	*	*	1	0	0	1	
820.00002 - 1040	*	*	*	*	0	1	1	1	

Note: * indicates a "don't care" condition.

102. Test data AC3/13. The following data applies to conditions where the output frequency has been set to be >32.5 MHz. Measurements have been taken with a carrier frequency of 100 MHz unless otherwise stated. RF levels quoted are with the output level set to 7 dBm unless otherwise noted.

TRI base RF level -15 dBm, nominal square wave.

TR2 collector RF level -2 dBm.

D24 cathode RF level -4 dBm.

SKCS RF level -5 dBm.

103. Table 18 gives a list of the expected output voltages on the open collector outputs of IC4.

TABLE 18 DC VOLTAGES ON IC4 OUTPUTS AC3/13

Carrier		IC4	pin numbe	ers		
frequency	2	4	12	10	8	
1040 MHz	15	15	15	15	0.13	
520 MHz	0.15	4.81	4.37	9.16	11.67	
260 MHz	15	0.15	5.18	2.87	10.79	
130 MHz	15	15	15	0.15	7.86	
65 MHz	15	15	15	15	0.13	

104. The following data applies to conditions where the output frequency has been set to <32.5 MHz. Measurements generally refer to a carrier of 10 MHz unless otherwise stated.

TR3 collector RF level -14 dBm.

PLCT RF level -15 dBm.

105. The following data applies to AC13 (2019) only.

C110 Carrier 530 MHz -5 dBm, sub-harmonic -24 dB.
Carrier 1040 MHz -3 dBm, sub-harmonic -10 dB.

TR5 collector Carrier 530 MHz 3 dBm, sub-harmonic -27 dB.
Carrier 1040 MHz 0 dBm, sub-harmonic -7 dB.

TR6 base Carrier 530 MHz -8 dBm, sub-harmonic -40 dB. Carrier 1040 MHz -9 dBm, sub-harmonic -33 dB.

106. Realignment procedure. Connect an r.f. signal source to PLDF, level -11 dBm.

LF Channel:

Monitor output from PLCT (providing a 200 Ω load impedance). Select each of the low-pass filters in turn by keying-in the SET FREQ on the 2018/19 keyboard, and check the PASS BAND ripple and relative attenuation at the 2*f (min) FREQ.

Nominal output level:
PASS BAND ripple:
2*f (min) level:

40 mV (r.m.s. p.d.) into 200 Ω *

not greater than 4 dB

Better than -18 dBc for 32.5 - 4.0625 MHz, better than -15 dBc for 4.0625-2.03126 MHz.

TABLE 19 LF LOW-PASS FILTER ALIGNMENT (1-32 MHz)

SET FREQ MHz	PASS BAND MHz	2*f (min) FREQ MHz
32	23 - 32.5	46
23	16.25 - 23	32.5
16	11.5 - 16.25	23
11	8.125 - 11.5	16.25
8	5.75 - 8.125	11.5
5	4.0625 - 5.75	8.125
4	2.875 - 4.0625	5.75
2.8	2.03126 - 2.875	4.0625

Monitor the output from PLCR pin 1 (200 Ω load impedance) to check the output to the b.f.o. board. Same conditions as above.

SET FREQ	PASS BAND	2*f (min) FREQ
MHz	MHz	MHz
2 1	11.5 - 12.03125 10.08 - 11.5	MHz 23 20

*NOTE: If 200 Ω load is made up by including a 150 Ω resistor in series with the 50 Ω input of the measuring instrument a 12 dB insertion loss will be introduced. This will result in a level of 10 mV across 50 Ω , or -27 dBm.

HF Channel:

107. Monitor output from SKCS (load impedance 50 Ω). Tests similar to those for the LF Channel are performed, but the HF Channel filters need to be individually adjusted to meet the following conditions:

Nominal output level: -6 dBm

PASS BAND ripple: not greater than 4 dB 2*f (min) level: better than -20 dBc.

- (1) To trim the 520 and 368 MHz low-pass filters, unsolder sliders on printed coils and re-position as required. (There is no need to switch off the power supplies.) Moving the sliders towards the filter capacitors will reduce the inductance and so raise band edge frequency. Providing the PASS BAND ripple and 2*f (min) level are correct the actual band edge frequency is unimportant.
- (2) To trim the "turret" low-pass filters, start with the ferrite slugs flush with the turret tops. Wind the slug in the lower numbered coil downwards until the filter band edge drops by 1 dB; then unwind 1 full turn. Repeat this operation for the second coil. Finally check the

conditions above and make further minor adjustments as necessary.

TABLE 20 HF LOW-PASS FILTER ALIGNMENT (46-520 MHz)

SET FREQ MHz	PASS BAND MHz	2*f (min) FREQ MHz
520	260 - 520	736 **
368	260 - 368	520
260	184 - 260	368
184	130 - 184	260
130	92 - 130	184
92	65 - 92	130
65	46 - 65	92
46	32.5 - 46	65

** NOTE: 520 MHz low-pass filter is checked down to 260 MHz (rather than 368 MHz) to ensure correct operation of frequency doubler (2019 only).

108. Frequency doubler. Monitor the output from SKCS. Select the three SET FREQ points in turn and check the level of "doubled" signal, its subharmonics and harmonics (up to about 1.2 GHz) across the appropriate INPUT FREQ range. The following conditions should be met for the "doubled" signal:

Nominal output level: -6 dBm (±3 dB)
Level of sub-harmonics/harmonics: Better than -35 dBc.

TABLE 21 FREQUENCY DOUBLER AC13

SET FREQ	INPUT FREQ RANGE	OUTPUT FREQ RANGE
MHz	MHz	MHz
660	260 - 330	520 - 660
820	330 - 410	660 - 820
1040	410 - 520	820 - 1040

AC4: Output amplifier

109. If, for any reason, it is necessary to remove the board AC4 from the instrument take care not to damage the integral Beryllium Oxide washer in TR10. The device is robust but it should be protected from accidental damage. If it is necessary to remove the heat sink from the stud, ensure that the nut is not overtightened. A tightening torque of 0.8 Nm is recommended by the manufacturer. See Notes and Cautions re the disposal of defective devices.

110. Control data AC4

Address IC No. Data lines Data sent

A7L1 4 DO-D7 Insertion loss control data

Insertion loss control data. Binary number of between 0 and 255 provides fine control level, 255 gives minimum level and 0 gives maximum level. Data to be sent is calculated by the microprocessor from the data entered to compensate for insertion loss.

Address	IC No.	Data lines	Data sent			
A7L2	6	DO-D7	The 8 1.s.b's of a 10 bit number used to control the r.f. output level from AC4. The 10 bit number is a number between 0 and 1000 which can control the output level with a 1 mV p.d. resolution. The number IC6 is set to is not updated until the m.s.b. is sent on A7L3.			
A7L3	6 2 2	D0-D1 D6 D7	The m.s.b's of the number sent to A7L2. High for frequencies of 32.50001 to 1040 MHz. High for frequencies of 32.5 MHz or less.			
111. Test	data AC4.	All test d	ata results are with the a.m. off unless			
IC3,	pin I		If 99% a.m. is set an audio signal should t whose negative peaks almost reach 0 V.			
IC3,	pin 7	-0.66 V a	DC voltage typically -1.5 V at 10 MHz, -1.2 V at 520 MHz, -0.66 V at 1040 MHz. DC level at intermediate carrier frequencies is linearly interpolated between these voltages.			
IC3,	pin 8		DC voltage typically -2.9 V at 10 MHz, 13.4 V at 520 MHz, -4.1 V at 1040 MHz.			
IC3,	pin 14		e at 520 MHz carrier typically 1.69 V at 7 dBm, 13 dBm, 0.546 V at -2.9 dBm.			
IC1,	pin 8		e at 520 MHz carrier typically 1.61 V at 7 dBm, 13 dBm, 0.471 at -2.9 dBm.			
IC2,	pin 9	Logic hig	h for carriers >32.5 MHz.			
IC2,	pin 5	Logic hig	h for carriers <32.5 MHz.			
TP2			ge. Will be between 0 V and -8 V if the stem is operating.			

AC5: Amplitude modulator

112. If, during the course of fault finding on AC5, it is necessary to remove or replace X2 ensure that when it is replaced the metal case is soldered to the printed board in the same way as originally manufactured. Failure to do so will result in poor a.m. performance.

113. Control data AC5

Latch Address	IC No.	Data Lines	Data sent
A7L0	4 .	D0-D6	7 bit binary number between 0 and 99 corresponding to the modulation depth set in %.
	2	D7	Single bit instruction that is set high for r.f. levels of 7.1 dBm or greater. In this mode the a.m. is set off and the mod. depth is set to 0%.

114. Test data AC5

IC4, pin 4	With a.m. on typically 6.5 V p-p audio.
IC3, pin 6	With a.m. set to 99% audio signal 5 V p-p decreasing linearly with reducing a.m. depth.
TR3 collector	-0.2 V for r.f. levels <7 dBm, -15 V for r.f. levels >7 dBm.
X1, pin 1	RF signal -6 dBm square wave.
X2, pin 5	RF signal 0 dBm square wave.
X2, pin 1	RF signal -18 dBm square wave.
TR1 collector	RF signal -12 dBm square wave.

AD1 : Display

115. The 1.c.d. units are driven by square waves which are either in phase or out of phase in order to avoid generating any d.c. component across the display. In order to fault find on parts of the circuit where the drive waveform has been converted to a square wave use a dual channel oscilloscope. Connect one input to the backplane drive on pin 1 or pin 80 of the carrier frequency display X1. Connect the second input to the point being tested and then observe the second input square wave is in phase or out of phase with the backplane drive. An in phase signal will result in a clear segment and an out of phase signal will result in a dark segment. The maintenance kit contains information on the use of the l.c.d. insertion and extraction tools.

116. Control data ADI

TABLE 22 CONTROL DATA AD1

Address	Data Lines	IC No.	Data sent
A5L0	D4-D7	4	Frequency display m.s.d.
220	D0-D3	5	Frequency display second m.s.d.
A5L1	D4-D7	6	Frequency display third m.s.d.
	D0-D3	7	Frequency display fourth m.s.d.
A5L2	D4-D7	8	Frequency display fifth m.s.d.
	D0-D3	9	Frequency display sixth m.s.d.
A5L3	D4-D7	10	Frequency display seventh m.s.d.
	D0-D3	11	Frequency display 1.s.d.
A5L4	D0-D3	21	Modulation display m.s.d.
A5L5	D4-D7	22	Modulation display second m.s.d.
	D0-D3	23	Modulation display 1.s.d.
A5L6	D4	27	RF level display m.s.d.
	D0-D3	29	RF level display second m.s.d.
A5L7	D4-D7	30	RF level display third m.s.d.
	D0-D3	31	RF level display 1.s.d.
A5L8	DO-D2	8 & 18	Frequency display decimal point. Lines decoded as 1 out of 8. A 0 gives a decimal point to the right of the m.s.d. and this moves to the right with increasing decoded output. An output of 7 gives no decimal point.
	D3-D4	26	Modulation display decimal point. Lines decoded as 1 out of 4. An output of 0 gives a decimal point to the right of m.s.d. and this moves to the right with increasing decoded output. An output of 4 gives no decimal point.
	D4-D6	27	RF level display decimal point. Lines decoded as 1 out of 4. An output of 0 gives a decimal point to the right of the m.s.d. and this moves right with increasing output. An output of 3 gives no decimal points.
A5L9	D0 D1 D2 D3 D4 D5 D6	3 3 3 12 12 12	Frequency display REMOTE annunciator. Frequency display ADDR annunciator. Frequency display LIMIT. Frequency display MHz. Frequency display kHz. Frequency display Hz. Frequency display EXT STD. Modulation display OFF.

TABLE 22 CONTROL DATA ADI (contd.)

Address	Data Lines	IC No.	Data sent
A5L10	D0 .	20	Modulation display EXT.
	D1	20	Modulation display LIMIT.
	D2 .	20	Modulation display AM.
	D3	20	Modulation display FM.
	D4	24	Modulation display %.
	D5	24	Modulation display MHz.
	D6	24	Modulation display kHz.
	D7	24	Modulation display Hz.
A5L11	D0	28	RF level display OFF.
	D1	28	RF level display REV PWR.
	D2	28	RF level display LIMIT.
	D3	28	RF level display - (minus sign).
	D4	32	RF level display + (vertical bar of + sign).
	D5	32	RF level display dBm.
	D6	32	RF level display dB.
	D7	32	RF level display V.
A5L12	D0	33	RF level display mV.
	D1	33	RF level display µV.
	D2	33	RF level display e.m.f.
	D3 ·	33	RF level display p.d.

AD2: Motherboard

117. Control data AD2. The data to control the 10 dB step attenuator and the RPP is latched on AD2 by IC1 address A6L10. The 10 dB step attenuator control data is as in Table 23 below.

TABLE 23 10 dB STEP ATTENUATOR CONTROL DATA AD2

Required attenuation dB	D5	D4	Data D3	sent D2	D1	D0
0	1	1	1	1	1	1
10	1	1	1	. 1	0	1
20	1	1	1	0	1	1
30	1	1	1	0	0	1
40	0	1	1	1	0	1
50	0	1	1	0	1	1
60	0	1	1	0	0	1
70	0	1	0	1	0	1
80	0	1	0	0	1	1
90	0	1	0	0	0	1
100	0	0	0	1	0	1
110	0	0	0	0	1	1
120	0	0	0	0	0	1

If the RPP is tripped it can reset by sending a logic 0 on A6L10 D0 followed by a logic 1 on the same address. Sending a logic 0 on A6L10 D0 will cause the RPP reed relay to go open circuit.

AD3: Modulation oscillator and f.m. control

118. Control data AD3. The latch A6L15 controls the modulation oscillator and the type of modulation being used. The data sent to A6L15 is as follows:

TABLE 24 MOD OSC CONTROL DATA AD3

MOD OSC FREQ Hz	Do D3	ata or D2	n DO D1	
300	0	0	0	0
400	0	0	0	1
1000	0	0	1	0
3000	0	0	1	1
6000	1	1	0	0
OFF	1	0	0	0

D4 High for internal modulation.

D5 High if f.m. is on

D6 High if the mod. a.1.c. is on

D7 High if a.m. is on

119. The latches A6L14, A6L12 and A6L13 control the f.m. deviation. The data sent is calculated by first determining the deviation required of the oscillators on AB3 after allowing for division by AB2 and frequency translation by the b.f.o. band. This deviation is referred to as the fundamental deviation. The data sent to A6L14 is given in Table 25 below.

TABLE 25 FM DEVIATION CONTROL DATA AD3

Fundamental deviation kHz	D7	Data D6	sent D5	to A6 D4	L14 I(C17 o D2		D0	Multiplier
5120 - 5200	1	1	1	ı	1	1	1	1	0.1
5120 - 2560	1	0	0	0	0	0	0	0	0.2
2560 - 1280	0	1	0	0	0	0	0	0	0.4
1280 - 640	1	0	0	0	0	0	0	0	0.8
640 - 320	0	1	0	0	0	0	0	0	1.6
320 - 160	1	0	0	0	0	0	0	0	3.2
160 - 80	0	1	0	0	0	0	0	0	6.4
80 - 40	1	0	0	0	0	0	0	0	12.8
40 - 20	0	1	0	0	0	0	0	0	25.6
20 - 10	0	0	1	0	0	0	0	0	51.2
0 - 10	0	0	0	1	0	0	0	0	102.4

120. The multiplier shown in the right-hand column above is used to derive the data sent to A6L12 and A6L13. If the multiplier is multiplied by the fundamental deviation in kHz the resulting number is between 0 and 1023 and can be expressed as a 10 bit binary number. This number is sent as 2 bytes. The eight least significant digits are sent to A6L12 followed by the two most significant digits to A6L13 on D0 and D1. The setting of the 10 bit D-A receiving this data, IC15, is only updated when the most significant bit is sent. The data sent to A6L11 is an 8 bit number, usually between binary 80 and 200, which is calculated from information stored in the EAROM store. Is is instrument dependent and therefore has no unique values.

121. Test data AD3

D4 anode -7.5 V d.c.

IC1, pin 1 Audio signal at modulation frequency set 3.2 V p-p.

IC1, pin 7 Audio signal 3.2 V p-p.

IC7, pin 14 INT MOD 3.2 V p-p audio.

EXT MOD, audio signal corresponding to the external modulation input.

IC10, pin 1 INT MOD, no signal.

EXT MOD, signal corresponding to external modulation input.

IC10, pin 7 INT MOD, 3.2 V p-p audio signal at mod. osc. frequency. EXT MOD, audio signal equal to the ext. mod. input.

IC6, pin 1 Audio signal 900 mV p-p. If EXT MOD is set its level should be independent of input level for input levels of 800 mV to 1.2 V r.m.s.

IC8, pin 7 6 V p-p audio signal.

D2 anode -2.6 V d.c.

IC8, pin 1 DC voltage between 0 V and -8 V. Typically -5 V on INT MOD.

122. All the following data assumes INT MOD is selected.

IC9, pin 1 With FM ON 12 V p-p audio, FM OFF - no signal.

IC9, pin 7 With AM ON - typically 6.7 V p-p, AM OFF - no signal.

IC12, pin 6 FM ON, carrier 520 MHz (typically) 5 V p-p audio. FM ON, carrier 260.1 MHz (typically) 7.4 V p-p audio.

IC16, pin 6 FM ON, carrier 520 MHz, f.m. deviation 9.9 kHz typically 4.9 V p-p audio.

FM ON, carrier 520 MHz, f.m. deviation 5.2 MHz typically 2.5 V p-p audio.

IC19, pin 6 FM ON, carrier 520 MHz, f.m. deviation 5.2 MHz typically 9.8 V p-p audio.

ATO and ATI: 10 dB step attenuator

- 123. Except for simple faults which do not affect the main r.f. path on ATI, it is not recommended that repairs are attempted on ATI unless very accurate attenuator measuring equipment is available. It is generally not advisable to attempt to remove the r.f. cover over ATI, but if the cover is removed do not attempt to adjust or remove ATI since to do so can alter the calibration of the pads. If it is established that one of the micro-switches required adjustment this can be accomplished by the following procedure:
 - (1) Adjust the large nylon nut so that the armature of the solenoid pulls in when between 13.5 V and 15 V d.c. is applied to the coil. The d.c. must be applied with SKLP disconnected from AT2.
 - (2) Energize all the solenoids except the one being adjusted.
 - (3) Connect a short circuit across SKAZ and an ohmmeter across SKBA. As the armature is manually closed a change of resistance should be observed when the micro-switch nearest SKBA operates. Adjust the corresponding adjustment screw so the switch operates at mid-travel.
 - (4) Repeat (3) with the short circuit across SKBA and the meter across SKAZ for the other micro-switch of the pad being adjusted.
 - (5) Lock the adjustment nut and screws with locking varnish.

IC3, pin 13 TTL level. Low unless RPP has been tripped.

AT2: Attenuator control

124. Test data AT2

IC4, pin 8		Normally low but on pressing the r.f. es high for 40 ms.
TR3 collector		egulated 10 V. Goes to unregulated 25 V en r.f. level key is pressed.
IC3, pin 8	TTL level.	Low except when attempting to reset the RPP.
IC3, pin 2	TTL level.	Low unless reverse power has been applied.

TABLE 26 VOLTAGES ON PLP, AT2

			PLP	pin n	umbers		
RF LE	EVEL 1	1 3		4	5	6	7
0 d	1Bm 10	V 0	V	0 V	0 V	0 V	0 V
-10 d	lBm 10	V O	V	0 V	0 V	0 V	10 V
-20 d	lBm 10	V 0	V	0 V	0 V	10 V	0 V
-30 d	1Bm 10	V 0	V	0 V	0 V	10 V	10 V
-40 d	lBm 10	V 10	V	0 V	0 V	o v	10 V
-50 d	lBm 10	V 10	V	0 V	0 V	10 V	0 V
-60 d	1Bm 10	V 10	V	0 V	0 V	10 V	10 V
-70 d	1Bm 10	V 10	V	0 V	10 V	o v	10 V
-80 d	lBm 10	V 10	V	0 V	10 V	10 V	0 V
-90 d	lBm 10	V 10	V	0 V	10 V	10 V	10 V
-100 d	lBm 10	V 10	V 1	0 V	10 V	0 V	10 V
-110 d	lBm 10	V 10	V 1	0 V	10 V	10 V	0 V
-120 d	IBm 10	V 10	V 1	0 V	10 V	10 V	10 V

Where the above table shows a voltage of 10 V this is taken as being the nominal unregulated voltage that appears on pin 1. Where 0 V is shown there will be a small positive voltage, not exceeding 0.4 V, due to the saturation voltage of the driver IC2 on AD2.

INSTRUMENT CALIBRATION

EAROM initialization

125. If the EAROM store on AA2 Microprocessor board has been replaced or erased, it is first necessary to set the EAROM to sensible stored values. After unlocking the second functions use Second Function 9 to enter and store 0 if the instrument is a 2018 and a 1 if the instrument is a 2019. Then enter the required r.f. level units into Second Function 5 and set the GPIB address (if fitted). Then enter valid instrument settings into the instrument stores labelled 10 to 19. If it is required to check that the f.m. system is functioning, enter valid f.m. tracking numbers into the f.m. tracking points at the carrier frequency of interest. On completion select Second Function '.' (decimal point) to re-calculate and store the amended EAROM check sum data.

Internal frequency standard

126. Using a frequency counter operated from a high accuracy frequency standard monitor the frequency standard output from the rear panel socket. The frequency standard may be adjusted without removing the external covers of the instrument by adjusting R1 on AA/BO. Access to R1 is gained using a small screwdriver inserted through the group of vents on the right-hand side of the instrument at the top front corner. R1 is located in line with the vent that is second from the rear of that group of vents.

RF level

- 127. Calibration of the output r.f. level requires the access to second function operations. An accurate power meter is required to set up the r.f. level calibration. The 10 dB step attenuator contributes significantly to level errors for outputs below -3.0 dBm. Specialized equipment is required to set up the attenuator and is not covered in detail in this procedure. The following procedure is used to set up the r.f. level at levels greater than -3.1 dBm. If the recalibration is required only on a routine basis (i.e. their has been no major fault in the level control system) steps (2) and (3) may be omitted if the difference in r.f. level between 7 dBm and -2.9 dBm is 9.9 dB ±0.15 dB.
 - (1) Enter SECOND FUNCT "0" and overcome the second degree protection by carrying out the Second level operation unlocking procedure. Details of this procedure are given in Chap. 4, page 38.
 - (2) Set the carrier to 10 MHz and enter SECOND FUNCT "7". Enter the number 050 on the keypad followed by the STORE key. Repeat this procedure at 520 MHz and 1040 MHz (only if it is a 2019) and entering the numbers 100 and 170 respectively.
 - (3) Set the carrier to 10 MHz and the level to 7 dBm. Adjust R86 on AC4 for an output of 7 dBm measured on a power meter at the r.f. output connector. Set the output level to -2.9 dBm. Adjust R89 on AC4 to obtain the correct output level. Repeat steps 2 and 3 until levels are correct to within 0.1 dB.
 - (4) The output level can now be accurately set up from the front panel alone by adjusting the calibration at 3 carrier frequencies using the second function operation. Set the carrier to 10 MHz and the level to 7 dBm. Enter SECOND FUNCT "7". The output level may be adjusted by entering a 3 digit number between 000 and 255 followed by the STORE key.

Note...

Do not exceed the number entered at 520 MHz - in this case 100.

Increasing the number entered will increase the output level. When a satisfactory entry is obtained this procedure is repeated at a carrier frequency of 520 MHz. In this case the number entered should not be less than that stored at 10 MHz and should not be more than that stored at 1040 MHz. After completing the entry at 520 MHz repeat the same procedure at 1040 MHz if the instrument is a 2019. The number entered should not be less than that entered at 520 MHz.

- (5) Check the r.f. level accuracy at 7 dBm and -2.9 dBm is better than ± 0.4 dB from 10 MHz to 520 MHz, and better than 0.8 dB from 520 MHz to 1040 MHz. On 2019, if necessary, the calibration number at 1040 MHz can be adjusted to give the best average accuracy from 520 MHz to 1040 MHz.
- (6) On completion of step (5) select SECOND FUNCT '.' to recalculate and store the amended EAROM check sum data.
- (7) Relock the second function by entering SECOND FUNCT "0".
- (8) After calibrating the r.f. level it is advisable to check the a.m. calibration.

AM calibration

128. An accurate modulation meter and a distortion meter are required to calibrate the a.m.

- (1) Set R23 on AC5 (PRE-MOD) fully clockwise.
- (2) Set the instrument to give 0 dBm at 100 MHz with the a.m. set to internal modulation at 1 kHz rate and 80% depth. Adjust R30 on AD3 to give 80% modulation depth as measured by the modulation meter.
- (3) Adjust R23 on AC5 to give minimum a.m. distortion. Recheck step (2).
- (4) Set the carrier frequency to 400 MHz and check that the a.m. distortion and level accuracy is within specification.
- (5) Monitor pin 14 of IC3 on AC4 with a d.c. coupled oscilloscope. Set the modulation depth to 99%. Switch the a.m. off temporarily and note the d.c. voltage level observed on the oscilloscope. Switch the a.m. back on and adjust R77 on AC4 such that the negative tips of the sine wave on pin 14 of IC3 come to a voltage, with respect to ground, of 1% of that noted previously.
- (6) Set the instrument to give 80% depth at 300 Hz rate internal modulation. Adjust R95 on AC4 to give the minimum ripple at the modulation frequency on IC1, pin 1 on AC4 (TP2).

FM calibration

- 129. An accurate modulation meter is required to calibrate the f.m. Calibration adjustments can take one of two forms. If the f.m. is out of calibration at all carrier frequencies and deviations by a consistent percentage the calibration can be adjusted using R33 on AD3. If, however, recalibration is necessary because of work carried out which may result in less predictable changes (e.g. to AB3) the f.m. should be recalibrated as follows under second function control. This recalibration can be easily accomplished using the GPIB if the modulation meter and 2018/2019 have a GPIB fitted and a controller with a suitable program is available.
 - (1) Set the instrument to 520 MHz at 0 dBm. Set the f.m. to 100 kHz deviation at 1 kHz rate in the internal mode. Set the carrier frequency increment size to 4.15 MHz. Enter SECOND FUNCT "O" and overcome the second degree protection by carrying out the Second level operation unlocking procedure. Details of this procedure are given in Chap. 4, page 38.
 - (2) Enter SECOND FUNCT "8". The r.f. level display will show a number corresponding to the tracking data at 520 MHz. This number is changed in order to obtain 100 kHz deviation as measured by the modulation meter. The number can be changed by entering a new 3 digit number or by using the increment keys. When the best value is found pressing the STORE key will store the data in the non-volatile memory. If the store key is not pressed the number will return to its previous setting when you exit from the second function mode.

- (3) Enter CARRIER FREQ and increment down in frequency by pressing the increment key. Then repeat the procedure given in section 2 at the new carrier frequency. Keep repeating this procedure until a carrier frequency of 437 MHz is reached. Then reset the carrier to 437.00001 MHz and repeat the procedure for entering new tracking data. This will complete the tracking of oscillator 4 on AB3.
- (4) The above procedure has to be repeated for the other 3 oscillators on AB3. Oscillator 3 is tracked by setting an incremental carrier of 3.45 MHz and starting at a carrier of 437 MHz. On reaching 368 MHz the carrier is reset to 368.00001 MHz and the last tracking point for oscillator 3 can be entered. Oscillator 2 is tracked by setting an incremental carrier of 2.95 MHz and starting at a carrier of 368 MHz. On reaching 309 MHz the carrier is set to 309.00001 MHz and the last tracking point for oscillator 2 can be entered. Oscillator 1 is tracked by setting an incremental carrier of 2.45 MHz and starting at a carrier of 309 MHz. On reaching 260 MHz the carrier is reset to 260.00001 MHz and the last tracking point for oscillator 1 can be entered.
- (5) On completion select SECOND FUNCT '.' (decimal point) to recalculate and store the amended EAROM check sum data.
- (6) Relock the second function by entering SECOND FUNCT "0".

External modulation

- 130. There is no need to calibrate the external modulation when the modulation a.l.c. is on. An accurate a.c. voltmeter and a modulation meter is required to calibrate the external modulation when the a.l.c. is off.
 - (1) Set the instrument to external modulation at any convenient modulation setting (a.m. or f.m.).
 - (2) Apply an external modulation source of 1 kHz frequency and adjust its level to give 1 V r.m.s. as measured by the voltmeter.
 - (3) Set the modulation a.l.c. on and note the reading on the modulation meter. Switch the a.l.c. off and adjust R16 on AD3 to give the same reading on the modulation meter.

Chapter 5, Annex A

MEASUREMENT OF PHASE NOISE IN SIGNAL GENERATORS

CONTENTS

Page

1 Side band noise
Reprint of article: 'Measurement of phase noise in signal generators'

Fig.

- 1 A typical phase noise plot for the TF 2020
- 2 Basic quadrature technique
- 3 Quadrature technique incorporating a p.1.1. to obtain phase quadrature at the mixer
- 4 Quadrature technique with a low noise pre-amplifier
- 5 FM discriminator method
- 6 An amplifier configuration
- 7 Residual phase noise characteristics

Side band noise

1. Side band noise measurements require the use of specialized equipment which is not always available to the user. Some methods of measuring side band noise are contained in this annex.



Chapter 6

REPLACEABLE PARTS

CONTENTS

Para	•	
1	Introductio	n
3	Abbreviatio	ns
4	Component v	alues
6	Ordering	
7	Electrical	components
7	Unit AAO	- RF BOX 1 AA/BO
8	Unit AA1	
9	Unit AA2	
10	Unit AA3	- FREQUENCY STANDARD
11	Unit AB1	- OUTPUT LOOP V.R.D.
12	Unit AB2	
13		- OSCILLATORS BOARD
14	Unit AB4	
15	Unit AB5	
16	Unit ACO	
17		- B.F.O. SYSTEM
18		- FILTER BOARD (2018 only)
19	Unit AC4	
20		- AMPLITUDE MODULATOR
21	_	- FILTER & FREQ DOUBLER BOARD (2019 only)
22		- DISPLAY BOARD
23		- MOTHER BOARD
24		- MOD. OSC. AND FM CONTROL BOARD
25	Unit AD4	
26		- POWER SUPPLY BOARD
27		
28		- 10DB STEP ATTENUATOR ASSEMBLY
29	Unit AT1	- ATTENUATOR BOARD
30	Unit AT2	- ATTENUATOR CONTROL
31	Mechanical	components

Fig. 1 Miscellaneous mechanical components

INTRODUCTION

- 1. Each sub-assembly or printed circuit board in this equipment has been allocated a reference designator code, e.g. AO, A1, A2 etc.
- 2. The complete component reference includes its reference designator as a prefix e.g. A2C1 (capacitor C1 on sub-assembly A2) but for convenience in the text and diagrams the prefix is omitted unless it is needed to avoid confusion. However when ordering replacements or in correspondence the complete component reference must be quoted.

Page

71/72

ABBREVIATIONS

3. Electrical components are listed in alpha-numerical order of their complete circuit reference and the following standard abbreviations are used:

ADC analogue-digital converter

CAP capacitor
CARR carrier
CARB carbon

CC carbon composition
CDE CNV code converter

CER ceramic
CERM cermet
CF carbon film
COAX coaxial
CON connector
CTR counter

DAC digital-analogue converter DEC/DMX decoder/demultiplexer

DECOD decoder
DIL dual in-line
DIV divider
DRIV driver

ELEC electrolytic ENCOD encoder

FEM female

FF flip-flop (bistable) FILTERCON filtering capacitor

GER germanium
GP general purpose

ICA integrated circuit, analogue ICD integrated circuit, digital

IND inductor INV Inverter

LD/T lead through

MF metal film
MG metal glaze
MISC miscellaneous
MO metal oxide
MP microprocessor

MP SUPP microprocessor support

MUX multiplexer

NET network

PC polycarbonate

PETP (polyester)polyethelene terephthalate

PS polystyrene PLL phase-locked loop Q/ACT quick acting

RECT rectifier RES resistor

RV resistor, variable

RX receiver

SAPPH sapphire
SEC secondary
SH REG shift register
SIL silicon

SIL silicon SW switch

T/LAG time lag
TANT tantalum
TOG toggle
TRANS transistor
TX transmitter

VAR variable

VREG voltage regulator

WW wirewound

! static sensitive component

% + asymmetric tolerance

COMPONENT VALUES

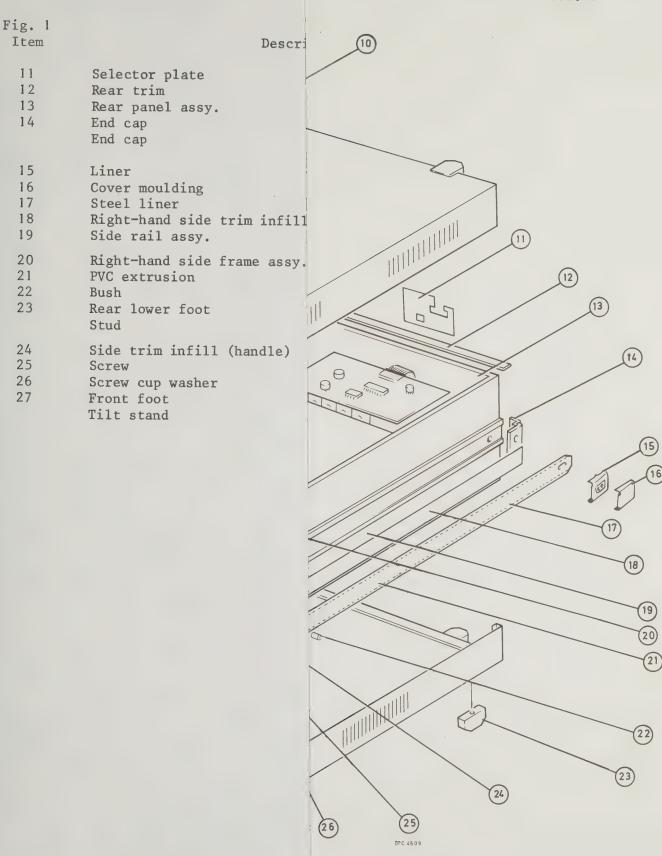
- 4. One or more of the components fitted in the equipment may differ from those listed in this chapter for any of the following reasons:
 - (a) Components indicated by a * have their values selected during test to achieve particular performance limits.
 - (b) Owing to supply difficulties, components of different value or type may be substituted provided the overall performance of the equipment is maintained.
 - (c) As part of a policy of continuous development, components may be changed in value or type to obtain detail improvements in performance.
- 5. When there is a difference between the component fitted and the one listed, always use as a replacement the same type and value as found in the equipment.

ORDERING

- 6. When ordering replacements, address the order to our Service Division (address on rear cover) or nearest agent and specify the following for each component required:-
 - (1) Type and serial number of equipment.
 - (2) Complete circuit reference.
 - (3) Description.
 - (4) Part number.

#As given on the serial number label at the rear of the equipment; if this is superseded by a model number label, quote the model number instead of the type number.





ORDERING

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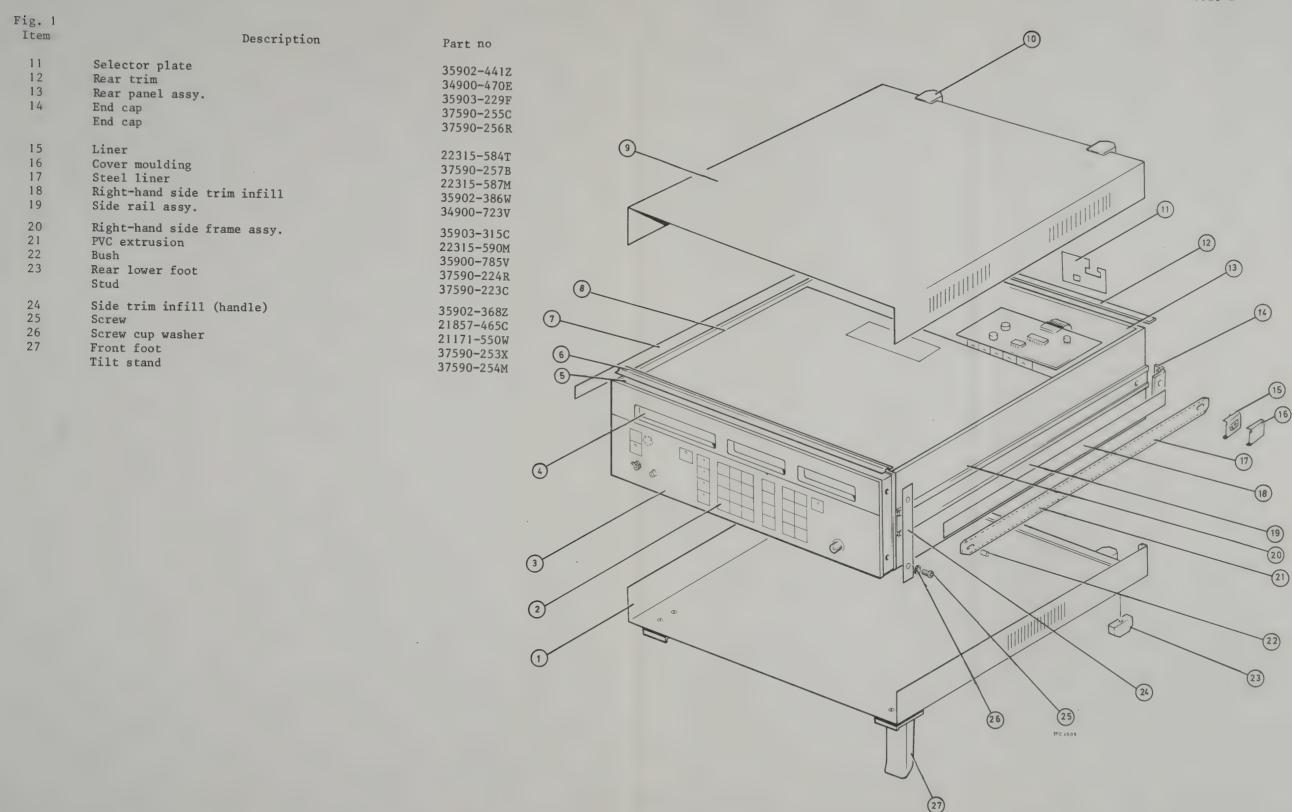


Fig. 1 Miscellaneous mechanical parts



Circuit	Description	Part Number
Unit AAO	- RF BOX 1 AA/B0(44990-351V)	Issue 9
7. When	ordering, prefix circuit reference with AAO	l
C1 C2 C3 C4 C5	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C6 C7 C8 C9 C10	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C11 C12 C13 C14 C15	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C16 C17 C18 C19 C20	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C21 C22 C23 C24 C25	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C26 C27 C28 C29 C30	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C31 C32 C33 C34 C35	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C36 C37 C38 C39 C40	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K

Circuit	Description	Part Number
Unit AAC	- RF BOX 1 AA/BO	(Contd.)
C41 C42 C43 C44 C45	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C46 C47 C48 C49 C50	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C51 C52 C53 C54 C55	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C56 C57 C58 C59 C60	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C61 C62 C63 C64 C65	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C66 C67 C68 C69 C70	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C71 C72 C73 C74 C75	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C76 C77 C78 C79 C80	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C81 C82 C83	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K

Circuit Ref	Description	Part Number
Unit AAO	- RF BOX 1 AA/BO	(Contd.)
C84 C85	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K
C86 C87 C88 C89	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C91 C92 C93 C94 C95	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C96 C97 C98 C99	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C101 C102 C103 C104 C105	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C106 C107 C108 C109 C111	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 500V 20%+ L/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-714F
C112 C113 C114 C115 C116	CAP CER .001UF 500V 20%+ L/T	26373-714F 26373-714F 26373-714F 26373-714F 26373-714F
C117 C118 C119 C120 C121 D1 IC1 L1 L2 L3 L4 L5	CAP CER .001UF 500V 20%+ L/T CAP CER .001UF 500V 20%+ L/T CAP TANT 4.7UF 35V 20% BEAD CAP TANT 4.7UF 35V 20% BEAD CAP ELEC 47UF 10V 20%+ DIODE ZENER 1N825/A 6.2V 5% UA7805 IND CHOKE 100UH 10%	26373-714F 26373-714F 26486-219P 26486-219P 26415-809E 28371-494Z 28461-707G 23642-561W 23642-561W 23642-561W 23642-561W 23642-561W 23642-561W

Circuit Ref	Description	Part Number
Unit AAO	- RF BOX 1 AA/BO	(Contd.)
L7 L8 L9 L10	IND CHOKE 100UH 10% IND CHOKE 100UH 10% IND CHOKE 100UH 10% IND CHOKE 100UH 10%	23642-561W 23642-561W 23642-561W 23642-561W
L11 L12 L13 L14 L15	IND CHOKE 100UH 10%	23642-561W 23642-561W 23642-561W 23642-561W
L16 L17 L18 L19 L20	IND CHOKE 100UH 10%	23642-561W 23642-561W 23642-561W 23642-561W 23642-561W
L21 L22 L23 L24 L25	IND CHOKE 100UH 10%	23642-561W 23642-561W 23642-561W 23642-561W 23642-561W
L26 L27 L28 L29 L30	IND CHOKE 100UH 10%	23642-561W 23642-561W 23642-561W 23642-561W 23642-561W
L31 L32 L33 L34 L45	IND CHOKE 100UH 10%	23642-561W 23642-561W 23642-561W 23642-561W 23642-561W
L46	IND CHOKE 100UH 10%	23642-561W
PLBW PLBX	CONN ASSY PLBW-PLDH CONN ASSY PLBX-SKAV	43129-692K 43129-664B
R1 R2	RV CERM 1KO LIN 1W PANEL MTG RES MF 620R 1/4W 2%	25748-499T 24773-268B
SKAR SKAU SKBC SKBD SKBE	CON RF SMB MALE 50 BKHD SOLDER CON RF SMB MALE 50 BKHD SOLDER CONN ASSY SKBC CONN ASSY CONN ASSY SKBE-SKBL	23444-331H 23444-331H 43129-669E 43129-671H 43129-670Z
SKBF SKBH	CONN ASSY CONN ASSY	43129-671H 43129-671H
Chap. 6		

Circuit Ref	Description	Part Number
Unit AAO	- RF BOX 1 AA/BO	(Contd.)
SKBJ SKBK SKBM	CONN ASSY CONN ASSY SKBK CONN ASSY SKBM-SKBP	43129-671H 43129-659C 43129-660X
SKBN SKBR SKBS SKBT SKBU	CONN ASSY SKBN CONN ASSY CONN ASSY CONN ASSY SKBT-PLDL CONN ASSY SKBU-SKCB	43129-661M 43129-678F 43129-671H 43129-663R 43129-662C
SKBV SKBY SKBZ SKCC SKCD	CONN ASSY CONN ASSY CONN ASSY CONN ASSY SKCC-SKCF CONN ASSY	43129-671H 43129-678F 43129-671H 43129-665K 43129-693M
SKCE SKCJ SKCK SKDH SKDJ	CONN ASSY SKCE CONN ASSY CONN ASSY SKCK-PLDJ CON RF SMB MALE 50 BKHD SOLDER CON RF SMB MALE 50 BKHD SOLDER	43129-666A 43129-693M 43129-667Z 23444-331H 23444-331H
SKDL	CON RF SMB MALE 50 BKHD SOLDER	23444-331H
x 6	10MHZ CRYSTAL OSCILLATOR	44990-337E
X11 X12	FERRITE BEAD FERRITE BEAD	41372-006T 41372-006T
X13 X14 X15	FERRITE BEAD FERRITE BEAD FERRITE BEAD	41372-006T 41372-006T 41372-006T

Part Circuit Description Ref Number Unit AA1 - L.S.D. LOOP Issue 1 8. When ordering, prefix circuit reference with AA1 44828-426W Complete unit C1 CAP PETP 0.1UF 100V 10% 26582-211B CAP PETP 1.0UF 100V 10% CAP CER 470PF 63V 10% PLATE
CAP CER 0.01UF 100V 20% DISC
CAP CER 0.01UF 100V 20% DISC C2 26582-217U 26383-582T 26383-055L C3 C4 C5 26383-055L CAP TANT .47UF 35V 20% BEAD
CAP TANT .47UF 35V 20% BEAD
CAP CER 0.01UF 100V 20% DISC
CAP CER 0.01UF 100V 20% DISC C6 26486-207L C7 26486-207L 26383-055L C8 C9 26383-055L C10 CAP CER 0.01UF 100V 20% DISC 26383-055L C11 CAP CER 0.01UF 100V 20% DISC 26383-055L C12 CAP CER 0.01UF 100V 20% DISC 26383-055L C13 C14 CAP CER 0.01UF 100V 20% DISC 26383-055L CAP CER 0.01UF 100V 20% DISC 26383-055L C15 CAP CER 0.01UF 100V 20% DISC 26383-055L CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC C16 26383-055L C17 26383-055L C18 26383-055L CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC C19 26383-055L C20 CAP CER 0.01UF 100V 20% DISC 26383-055L CAP CER 0.01UF 100V 20% DISC
CAP CER 0.01UF 100V 20% DISC
CAP CER 0.01UF 100V 20% DISC
CAP CER .0015UF 63V 10% PLATE
CAP CER 0.01UF 100V 20% DISC C21 26383-055L 26383-055L 26383-055L 26383-593A 26383-055L 26383-582T 26383-055L C22 C23 C24 C25 C26 CAP CER 0.01UF 100V 20% DISC CAP CER 470PF 63V 10% PLATE
CAP CER 470PF 63V 10% PLATE C27 26383-582T 26383-582T 28381-340V 28336-676J D1 C28 DIODE VAR CAP MVAM125 1V 500PF DIODE SIL 1N4148 100V JUNC D3 DIODE SIL 1N4148 100V JUNC 28336-676J D4 DIODE HOT CARR 1N5390 28349-005Z IC1 ICD FF D 74LS74 DUAL +EDG TR 28462-611A

 ICD FF D 74LS14 DSIZ

 ICD NAND 74LS10 TRIP 3INP
 28466-3511

 ICD CTR 74LS160 4BIT BIN PRE
 28464-123P

 ICD CTR 74LS160 4BIT BIN PRE
 28464-123P

 28464-123P
 28464-123P

 IC2 IC3 IC4 IC5

Circuit Ref	Description	Part Number
Unit AA1	- L.S.D. LOOP	(Contd.)
IC6 IC7 IC8 IC9 IC10	ICD CTR 74LS160 4BIT BIN PRE ICD CTR 74LS160 4BIT BIN PRE ICD FF D 74LS273 OCT +EDG TR ICD FF D 74LS273 OCT +EDG TR ICD FF D 74LS273 OCT +EDG TR	28464-123P 28464-123P 28462-615U 28462-615U 28462-615U
IC11 IC12 IC13 IC14 IC15	ICD FF D 74LS273 OCT +EDG TR ICD CTR 74LS160 4BIT BIN PRE	28462-615U 28464-123P 28464-123P 28464-123P 28464-123P
IC16 IC17	ICD NAND 74S133 13INP ICD NAND 74S133 13INP	28466-357V 28466-357V
L1 L2	IND CHOKE .47UH 10% IND CHOKE .47UH 10%	23642-547Y 23642-547Y
PLBL PLBM PLBN	CON PART PCB POST SQUARE PIN CON PART PCB POST SQUARE PIN CON PART PCB POST SQUARE PIN	23435-188V 23435-188V 23435-188V
R1 R2 R3 R4 R5	RES MF 6K8 1/4W 2% RES MF 2K2 1/4W 2% RES MF 3K3 1/4W 2% RES MF 1K0 1/4W 2% RES MF 2K2 1/4W 2%	24773-293D 24773-281Y 24773-285F 24773-273A 24773-281Y
R6 R7 R8 R9 R10	RES MF 2K2 1/4W 2% RES MF 2K2 1/4W 2% RES MF 1K0 1/4W 2% RES MF 1K0 1/4W 2% RES MF 1K0 1/4W 2%	24773-281Y 24773-281Y 24773-273A 24773-273A 24773-273A
R11	RES MF 1KO 1/4W 2%	24773-273A
TR1 TR2 TR3	TRANS NPN SIL ZTX109CL 20V TRANS PNP SIL BC308 25V TRANS NPN SIL ZTX109CL 20V	28452-771P 28433-455R 28452-771P

Circuit Ref	Description	Part Number
Unit AA2	- MICROPROCESSOR SYSTEM	Issue 4
9. When	ordering, prefix circuit reference with	AA2
	Complete unit	44828-427D
C1 C2 C3 C4 C5	CAP CER 0.01UF 100V 20% DISC CAP TANT 4.7UF 35V 20% BEAD CAP ELEC 100UF 25V 20%+ P/CCT CAP ELEC 100UF 25V 20%+ P/CCT CAP ELEC 100UF 25V 20%+ P/CCT	26383-055L 26486-219P 26423-243M 26423-243M 26423-243M
C6 C7 C8 C9 C10	CAP CER 0.01UF 100V 20% DISC	26383-055L 26383-055L 26383-055L 26383-055L 26383-055L
C11 C12 C13 C14 C15	CAP CER 0.01UF 100V 20% DISC CAP CER 470PF 63V 10% PLATE	26383-055L 26383-055L 26383-055L 26383-055L 26383-582T
C16 C17 C18 C20 C21	CAP ELEC 22UF 25V 20%+ CAP PETP 0.1UF 100V 10% CAP PETP 0.1UF 100V 10% CAP ELEC 100UF 25V 20%+ P/CCT CAP CER 470PF 63V 10% PLATE	26415-805K 26582-211B 26582-211B 26423-243M 26383-582T
C22 C23 C24 C25 C26	CAP CER 0.01UF 100V 20% DISC	26383-055L 26383-055L 26383-055L 26383-055L 26383-055L
C27 C28 C32	CAP CER 0.01UF 100V 20% DISC CAP TANT 4.7UF 35V 20% BEAD CAP ELEC 100UF 25V 20%+ P/CCT	26383-055L 26486-219P 26423-243M
D1 D2 D3 D4 D5	DIODE SIL 1N4148 100V JUNC DIODE ZENER BZY88C3VO 3V 5% DIODE ZENER BZY88C3VO 3V 5% DIODE ZENER BZY88C15 15V 5% DIODE SIL 1N4148 100V JUNC	28336-676J 28371-203G 28371-203G 28372-303M 28336-676J
D6 D7 D8 D9	DIODE SIL 1N4148 100V JUNC DIODE ZENER BZY88C15 15V 5% DIODE SIL 1N4148 100V JUNC DIODE SIL 1N4148 100V JUNC	28336-676J 28372-303M 28336-676J 28336-676J

Circuit Ref	Description		Part Number
Unit AA2	- MICROPROCESSOR SYSTEM		(Contd.)
IC1 IC2 IC3 IC4 IC5	ICD MP P8085A 8BIT NMOS ICD NAND 74LS00 QUAD 2INP ICD MP SUP 8155 2KRAM+I/O+TIM ICD BUFF 74LS245 OCT TXRX ICD BUFF 74LS244 OCT 3ST		28469-396K 28466-345H 28469-304E 28469-188B 28469-182T
IC6 IC7 IC8 IC9 IC10	ICD DEC/DMX 74LS138 3-8 ICD MP SUP 8155 2KRAM+I/O+TIM ICD PROM ER3400 1KX4BIT EA ICD BUFF 4049 HEX I ICD FF D 74LS273 OCT +EDG TR	0 0 0 0	28465-027F 28469-304E 28471-010H 28469-162Z 28462-615U
IC11 IC12 IC13	ICD LATCH 74LS373 OCT 3ST ICD DEC/DMX 74LS138 3-8 ICD B2732 EPROM A		28462-410E 28465-027F
IC14 IC15 IC16	ICD B2732 EPROM B Set of four ICD B2732 EPROM C ICD B2732 EPROM D	!	44533 – 027B
PLBC PLBD PLBE PLBF PLBH	CON PART PCB POST SQUARE PIN		23435-188V 23435-188V 23435-188V 23435-188V 23435-188V
PLBJ PLBK	CON PART PCB POST SQUARE PIN CON PART PCB POST SQUARE PIN		23435-188V 23435-188V
R1 R2 R3	RES MF 47K 1/4W 2% RES MF 10K 1/4W 2% RES MF 10K 1/4W 2%		24773-313H 24773-297M 24773-297M
R4 R5	RES MF 10K 1/4W 2% RES MF 3KO 1/4W 2%		24773-297M 24773-284J
R6 R7 R8 R9 R10	RES MF 3KO 1/4W 2% RES MF 3KO 1/4W 2% RES MF 3KO 1/4W 2% RES MF 1OK 1/4W 2% RES MF 1OK 1/4W 2%		24773-284J 24773-284J 24773-284J 24773-297M 24773-297M
R11 R12 R13 R14 R15	RES MF 15K 1/4W 2% RES MF 4K7 1/4W 2% RES MF 15K 1/4W 2% RES MF 330R 1/4W 2% RES MF 10K 1/4W 2%		24773-301P 24773-289W 24773-301P 24773-261D 24773-297M
R16 R17 R18 R19 R20	RES MF 3KO 1/4W 2% RES MF 10K 1/4W 2% RES MF 4K7 1/4W 2% RES MF 4K7 1/4W 2% RES MF 10K 1/4W 2%		24773-284J 24773-297M 24773-289W 24773-289W 24773-297M

Circuit Ref	Description	Part Number
Unit AA2	- MICROPROCESSOR SYSTEM	(Contd.)
R21 R22 R23 R24 R25	RES MF 10K 1/4W 2% RES MF 10K 1/4W 2% RES MF 15K 1/4W 2% RES MF 1KO 1/4W 2% RES MF 47K 1/4W 2%	24773-297M 24773-297M 24773-301P 24773-273A 24773-313H
TR1 TR2 TR3 TR4 TR5	TRANS PNP SIL BC307A 45V TRANS PNP SIL BC307A 45V TRANS NPN SIL ZTX107AL 45V TRANS NPN SIL ZTX107AL 45V TRANS NPN SIL ZTX107AL 45V	28435-227H 28435-227H 28455-421X 28455-421X 28455-421X
TR6 TR7 TR8 TR9	TRANS PNP SIL BC307A 45V TRANS NPN SIL ZTX107AL 45V TRANS PNP SIL BC307A 45V TRANS PNP SIL BC307A 45V	28435-227H 28455-421X 28435-227H 28435-227H
XL1	CRYSTAL 6.144MHZ FLY LDS	28312-054J

Circuit Ref	Description	Part Number
Unit AA3	- FREQUENCY STANDARD	Issue 4
10. When	ordering, prefix circuit reference with A	AA3
	Complete unit	44828-428T
C1 C2 C3 C4 C5	CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP TANT 4.7UF 35V 20% BEAD CAP CER 0.01UF 100V 20% DISC	26383-055L 26383-055L 26486-219P 26486-219P 26383-055L
C6 C7 C8 C9 C10	CAP TANT 4.7UF 35V 20% BEAD CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP PS 220PF 350V 2% CAP CER 0.01UF 100V 20% DISC	26486-219P 26383-055L 26383-055L 26516-329B 26383-055L
D1	DIODE SIL BA482 35V JUNC	28335-675R
IC1 IC2 IC3 IC4	ICD NAND 74LSOO QUAD 2INP ICD NOR 74128 QUAD 2INP BUF ICD CTR 74LS390 DUAL 4BIT DEC ICD CTR 74LS390 DUAL 4BIT DEC	28466-345H 28466-224S 28464-127R 28464-127R
L1	IND CHOKE 1.0UH 10%	23642-549L
PLBP PLBR	CON PART PCB POST SQUARE PIN CON PART PCB POST SQUARE PIN	23435-188V 23435-188V
R2 R3 R4 R5 R6	RES MF 10K 1/4W 2% RES MF 10K 1/4W 2% RES MF 4K7 1/4W 2% RES MF 10K 1/4W 2% RES MF 10OR 1/4W 2%	24773-297M 24773-297M 24773-289W 24773-297M 24773-249J
R7 R8 R9 R10 R11	RES MF 180R 1/4W 2% RES MF 1K0 1/4W 2% RES MF 180R 1/4W 2% RES MF 1K0 1/4W 2% RES MF 180R 1/4W 2%	24773-255V 24773-273A 24773-255V 24773-273A 24773-255V
TR1 TR2 TR3	TRANS PNP SIL BC308 25V TRANS NPN SIL ZTX109CL 20V TRANS NPN SIL ZTX109CL 20V	28433-455R 28452-771P 28452-771P

Circuit Ref	Description	Part Number
Unit AB1	- OUTPUT LOOP V.R.D.	Issue 3
11. When	ordering, prefix circuit reference with	n AB1
	Complete unit	44828-429P
C1 C2 C3 C4 C5	CAP CER .001UF 63V 10% PLATE CAP CER 0.01UF 100V 20% DISC CAP CER .001UF 63V 10% PLATE CAP CER .001UF 63V 10% PLATE CAP CER .001UF 63V 10% PLATE	26383-585M 26383-055L 26383-585M 26383-585M 26383-585M
C6 C7 C8 C9 C10	CAP CER .001UF 63V 10% PLATE CAP CER 0.01UF 100V 20% DISC	26383-585M 26383-055L 26383-055L 26383-055L 26383-055L
C11 C12 C13 C14 C15	CAP CER 0.01UF 100V 20% DISC	26383-055L 26383-055L 26383-055L 26383-055L 26383-055L
C16 C17 C18 C19	CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP CER 2.2PF 63V .5PF PLATE CAP TANT 22UF 16V 20% BEAD	26383-055L 26383-055L 26343-457R 26486-230B
D1 D4	DIODE SIL 1N4148 100V JUNC DIODE SIL 1N4148 100V JUNC	28336-676J 28336-676J
IC1 IC2 IC3 IC4 IC5	ICD DIV SP8607B ECL /2 PRESC ICD DIV SP8647B/10,11 TTL O/P ICD NAND 74SOON QUAD 2INP ICD FF D 74LS273 OCT +EDG TR ICD FF D 74LS273 OCT +EDG TR	28462-023B 28464-015W 28466-331D 28462-615U 28462-615U
IC6 IC7 IC8 IC9 IC10	ICD CTR 74LS196 4BIT DEC PRE ICD CTR 74196 4BIT DEC PR ICD CTR 74LS196 4BIT DEC PRE ICD CTR 74LS196 4BIT DEC PRE ICD FF D 74S74 DUAL +EDG TR	28464-016D 28464-004Y 28464-016D 28464-016D 28462-607K
IC11 IC12	ICD FF JK 74S112 DUAL -EDG TR ICD NAND 74S133 13INP	28462-015P 28466-357V
PLBS PLBT PLBU	CON PART PCB POST SQUARE PIN CON PART PCB POST SQUARE PIN CON PART PCB POST SQUARE PIN	23435-188V 23435-188V 23435-188V
R1 R2	RES CC 51R 1/8W 5% RES MF 10K 1/4W 2%	24331-989P 24773-297M

Circuit Ref	Description	Part Number
Unit AB1	- OUTPUT LOOP V.R.D.	(Contd.)
R3 R4 R5	RES MF 1K8 1/4W 2% RES CC 22R 1/8W 5% RES CC 100R 1/8W 5%	24773-279N 24331-988T 24331-997B
R6 R7 R8 R9 R10	RES MF 10K 1/4W 2% RES MF 2K7 1/4W 2% RES MF 3K3 1/4W 2% RES MF 56R 1/4W 2% RES MF 470R 1/4W 2%	24773-297M 24773-283L 24773-285F 24773-243H 24773-265M
R11 R12 R13 R14	RES MF 1K5 1/4W 2% RES MF 680R 1/4W 2% RES MF 2K2 1/4W 2% RES MF 2K2 1/4W 2%	24773-277U 24773-269K 24773-281Y 24773-281Y
TR1	TRANS NPN SIL BFR90 15V	28452 – 167U
Unit AB2	- DIVIDE-BY-TWO CHAIN AND FM DRIVE	Issue 1
12. When	ordering, prefix circuit reference with A	B2
	Complete unit	44828-430D
C1 C2 C3 C4 C5	CAP CER .001UF 63V 10% PLATE CAP CER .001UF 63V 10% PLATE CAP CER .001UF 63V 10% PLATE CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC	26383-585M 26383-585M 26383-585M 26383-055L 26383-055L
C6 C7 C8 C9 C10	CAP CER .001UF 63V 10% PLATE CAP CER 0.01UF 100V 20% DISC CAP CER .001UF 63V 10% PLATE CAP CER .001UF 63V 10% PLATE CAP CER .001UF 63V 10% PLATE	26383-585M 26383-055L 26383-585M 26383-585M 26383-585M
C11 C12 C13 C14 C15	CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP CER .039UF 50V 20% CHIP CAP CER 1.8PF 63V .5PF PLATE CAP CER 0.01UF 100V 20% DISC	26383-055L 26383-055L 26386-493F 26343-456C 26383-055L
C16 C17 C18 C19 C20	CAP CER .001UF 63V 10% PLATE CAP CER 0.01UF 100V 20% DISC	26383-585M 26383-585M 26383-585M 26383-585M 26383-055L

Circuit Ref	Description	Part Number
Unit AB2	- DIVIDE-BY-TWO CHAIN AND FM DRIVE	(Contd.)
C21 C22 C23 C24 C25	CAP CER 0.01UF 100V 20% DISC	26383-055L 26383-055L 26383-055L 26383-055L 26383-055L
C26 C27 C28 C29 C30	CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP TANT 4.7UF 35V 20% BEAD CAP TANT 4.7UF 35V 20% BEAD	26383-055L 26383-055L 26383-055L 26486-219P 26486-219P
C31 C32	CAP TANT 4.7UF 35V 20% BEAD CAP CER 22PF 63V 5% PLATE	26486-219P 26343-469N
D1 D2 D3 D4 D5	DIODE SIL 1N4148 100V JUNC	28336-676J 28336-676J 28336-676J 28336-676J
D6 D7 D8	DIODE SIL 1N4148 100V JUNC DIODE SIL 1N4148 100V JUNC DIODE SIL 1N4148 100V JUNC	28336-676J 28336-676J 28336-676J
IC1 IC2 IC3 IC4 IC5	ICD DIV SP8607B ECL /2 PRESC ICD DIV SP8604B ECL /2 PRESC ICD FF D 10231 M/SLAVE ICD FF JK 74S112 DUAL -EDG TR ICD FF JK 74LS112 DUAL -EDG TR	28462-023B 28462-022R 28462-610K 28462-015P 28462-020M
IC6 IC7 IC8 IC9 IC10	ICD AND 10104 QUAD 2INP ECL ICD NAND 74LS00 QUAD 2INP ICD FF D 74LS273 OCT +EDG TR ICD FF D 74LS175 QUAD +EDG TR ICA AMP NE5534AH H-PRF T099	28466-015G 28466-345H 28462-615U 28462-614E 28461-329V
L1 L2 L3	IND CHOKE 4.7UH 10% IND CHOKE 4.7UH 10% IND CHOKE 4.7UH 10%	23642-553J 23642-553J 23642-553J
PLBV PLCJ PLCK	CON PART PCB POST SQUARE PIN CON PART PCB POST SQUARE PIN CON PART PCB POST SQUARE PIN	23435-188V 23435-188V 23435-188V
R1 R2 R3 R4 R5	RES CC 100R 1/8W 5% RES MF 1K5 1/4W 2% RES MF 150R 1/4W 2% RES MF 51R 1/4W 2% RES CHIP 10R 5%	24331-997B 24773-277U 24773-253F 24773-242Z 24681-042H
R6	RES MF 4K7 1/4W 2%	24773-289W

Unit AB2 - DIVIDE-BY-TWO CHAIN AND FM DRIVE (Contd.) R7 RES MF 10K 1/4W 2% 24773-297M R8 RES MF 470R 1/4W 2% 24773-265M R9 RES MF 4K7 1/4W 2% 24773-242Z R11 RES MF 470R 1/4W 2% 24773-242Z R11 RES MF 470R 1/4W 2% 24773-297M R12 RES MF 10K 1/4W 2% 24773-299M R13 RES CC 51R 1/8W 5% 24331-997B R14 RES CC 100R 1/8W 5% 24331-997B R15 RES MF 10K 1/4W 2% 24773-297M R16 RES MF 2K7 1/4W 2% 24773-297M R18 RES MF 10K 1/4W 2% 24773-275H R19 RES MF 10K 1/4W 2% 24773-289W R20 RES MF 51R 1/4W 2% 24773-242Z R21 RES MF 2C0R 1/4W 2% 24773-242Z R21 RES MF 51R 1/4W 2% 24773-242Z R22 RES MF 51R 1/4W 2% 24773-242Z R23 RES CC 570R 1/8W 5% 24331-999P R24 RES CC 270R 1/8W 5% 24331-999P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-273A R27 RES MF 470R 1/4W 2% 24773-273A R28 RES MF 470R 1/4W 2% 24773-273A R29 RES MF 51R 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R8 RES MF 470R 1/4W 2% 24773-265M R9 RES MF 4K7 1/4W 2% 24773-289W R10 RES MF 51R 1/4W 2% 24773-242Z R11 RES MF 470R 1/4W 2% 24773-265M R12 RES MF 4K7 1/4W 2% 24773-289W R13 RES CC 51R 1/8W 5% 24331-989P R14 RES CC 100R 1/8W 5% 24331-997B R15 RES MF 10K 1/4W 2% 24773-297M R16 RES MF 2K7 1/4W 2% 24773-297M R16 RES MF 1K2 1/4W 2% 24773-297M R18 RES MF 1K2 1/4W 2% 24773-297M R18 RES MF 1K2 1/4W 2% 24773-297M R20 RES MF 51R 1/4W 2% 24773-275H R21 RES MF 220R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-242Z R22 RES MF 51R 1/4W 2% 24773-242Z R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-273A R27 RES MF 470R 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R8 RES MF 470R 1/4W 2% 24773-265M R9 RES MF 4K7 1/4W 2% 24773-289W R10 RES MF 51R 1/4W 2% 24773-242Z R11 RES MF 470R 1/4W 2% 24773-265M R12 RES MF 4K7 1/4W 2% 24773-289W R13 RES CC 51R 1/8W 5% 24331-989P R14 RES CC 100R 1/8W 5% 24331-997B R15 RES MF 10K 1/4W 2% 24773-297M R16 RES MF 2K7 1/4W 2% 24773-297M R16 RES MF 1K2 1/4W 2% 24773-297M R18 RES MF 1K2 1/4W 2% 24773-297M R18 RES MF 1K2 1/4W 2% 24773-297M R20 RES MF 51R 1/4W 2% 24773-275H R21 RES MF 220R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-242Z R22 RES MF 51R 1/4W 2% 24773-242Z R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-273A R27 RES MF 470R 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R9 RES MF 4K7 1/4W 2% 24773-289W R10 RES MF 51R 1/4W 2% 24773-242Z R11 RES MF 470R 1/4W 2% 24773-265M R12 RES MF 4K7 1/4W 2% 24773-289W R13 RES CC 51R 1/8W 5% 24331-989P R14 RES CC 100R 1/8W 5% 24331-997B R15 RES MF 10K 1/4W 2% 24773-297M R16 RES MF 10K 1/4W 2% 24773-297M R18 RES MF 10K 1/4W 2% 24773-297M R18 RES MF 10K 1/4W 2% 24773-297M R18 RES MF 1K2 1/4W 2% 24773-289W R20 RES MF 51R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-242Z R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-273A R27 RES MF 4K7 1/4W 2% 24773-273A R28 RES MF 1K0 1/4W 2% 24773-265M R28 RES MF 4K7 1/4W 2% 24773-265M R29 RES MF 51R 1/4W 2% 24773-265M R29 RES MF 51R 1/4W 2% 24773-265M R29 RES MF 1K0 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 10K 1/4W 2% 24773-297M R31 RES MF 10K 1/4W 2% 24773-297M R33 R25 R45 MF 10K 1/4W 2% 24773-297M R33 R25 R45 MF 10K 1/4W 2% 24773-297M R33 R45 MF 10K 1/4W 2% 24773-297M R33 R45 MF 10K 1/4W 2% 24773-297M R33 R45 MF 10K 1/4W 2% 2% 24773-297M R33 R45 MF 10K 1/4W 2% 2% 24773-297M R33 R45 MF 10K 1/4W 2% 2% 24773-297M R33 R45 MF 10K 1/4
R11 RES MF 470R 1/4W 2% 24773-265M R12 RES MF 4K7 1/4W 2% 24773-289W R13 RES CC 51R 1/8W 5% 24331-989P R14 RES CC 100R 1/8W 5% 24331-997B R15 RES MF 10K 1/4W 2% 24773-297M R16 RES MF 2K7 1/4W 2% 24773-297M R18 RES MF 10K 1/4W 2% 24773-297M R18 RES MF 1K2 1/4W 2% 24773-275H R19 RES MF 4K7 1/4W 2% 24773-275H R20 RES MF 51R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-257W R22 RES MF 51R 1/4W 2% 24773-257W R24 RES CC 51R 1/8W 5% 24331-989P R25 RES MF 1K0 1/4W 2% 24331-989P R26 RES MF 1K0 1/4W 2% 24773-273A R27 RES MF 470R 1/4W 2% 24773-273A R28 RES MF 470R 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R12 RES MF 4K7 1/4W 2% 24773-289W R13 RES CC 51R 1/8W 5% 24331-989P R14 RES CC 100R 1/8W 5% 24331-997B R15 RES MF 10K 1/4W 2% 24773-297M R16 RES MF 2K7 1/4W 2% 24773-297M R18 RES MF 10K 1/4W 2% 24773-297M R18 RES MF 1K2 1/4W 2% 24773-275H R19 RES MF 4K7 1/4W 2% 24773-242Z R20 RES MF 51R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-242Z R22 RES MF 51R 1/4W 2% 24773-242Z R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-273A R27 RES MF 470R 1/4W 2% 24773-265M R28 RES MF 470R 1/4W 2% 24773-265M R29 RES MF 1K0 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R13 RES CC 51R 1/8W 5% 24331-989P R14 RES CC 100R 1/8W 5% 24331-997B R15 RES MF 10K 1/4W 2% 24773-297M R16 RES MF 2K7 1/4W 2% 24773-283L R17 RES MF 10K 1/4W 2% 24773-297M R18 RES MF 1K2 1/4W 2% 24773-275H R19 RES MF 4K7 1/4W 2% 24773-289W R20 RES MF 51R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-257W R22 RES MF 51R 1/4W 2% 24773-242Z R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-273A R27 RES MF 470R 1/4W 2% 24773-273A R28 RES MF 470R 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R34 RES MF 10K 1/4W 2% 24773-297M R35 RES MF 10K 1/4W 2% 24773-297M R37 RES MF 10K 1/4W 2% 24773-297M R38 RES MF 10K 1/4W 2% 24773-297M R39 RES MF 10K 1/4W 2% 24773-297M R31 RES MF 10K 1/4W 2% 24773-297M R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R14 RES CC 100R 1/8W 5% 24331-997B R15 RES MF 10K 1/4W 2% 24773-297M R16 RES MF 2K7 1/4W 2% 24773-283L R17 RES MF 10K 1/4W 2% 24773-297M R18 RES MF 1K2 1/4W 2% 24773-275H R19 RES MF 4K7 1/4W 2% 24773-289W R20 RES MF 51R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-242Z R22 RES MF 51R 1/4W 2% 24773-242Z R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-273A R27 RES MF 4K7 1/4W 2% 24773-265M R28 RES MF 4K7 1/4W 2% 24773-265M R29 RES MF 1K0 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R34 RES MF 10K 1/4W 2% 24773-297M R35 RES MF 10K 1/4W 2% 24773-297M R37 RES MF 10K 1/4W 2% 24773-297M R38 RES MF 10K 1/4W 2% 24773-297M R39 RES MF 10K 1/4W 2% 24773-297M R30 RES MF 10K 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R32 RES MF 10K 1/4W 2% 24773-297M
R15 RES MF 10K 1/4W 2% 24773-297M R16 RES MF 2K7 1/4W 2% 24773-283L R17 RES MF 10K 1/4W 2% 24773-297M R18 RES MF 1K2 1/4W 2% 24773-275H R19 RES MF 4K7 1/4W 2% 24773-289W R20 RES MF 51R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-242Z R22 RES MF 51R 1/4W 2% 24773-242Z R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-273A R27 RES MF 470R 1/4W 2% 24773-265M R28 RES MF 4K7 1/4W 2% 24773-289W R29 RES MF 1K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R16 RES MF 2K7 1/4W 2% 24773-283L R17 RES MF 10K 1/4W 2% 24773-297M R18 RES MF 1K2 1/4W 2% 24773-275H R19 RES MF 4K7 1/4W 2% 24773-289W R20 RES MF 51R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-242Z R22 RES MF 51R 1/4W 2% 24773-242Z R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-273A R27 RES MF 470R 1/4W 2% 24773-265M R28 RES MF 4K7 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R17 RES MF 10K 1/4W 2% 24773-297M R18 RES MF 1K2 1/4W 2% 24773-275H R19 RES MF 4K7 1/4W 2% 24773-289W R20 RES MF 51R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-242Z R22 RES MF 51R 1/4W 2% 24773-242Z R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-265M R27 RES MF 470R 1/4W 2% 24773-265M R28 RES MF 4K7 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R18 RES MF 1K2 1/4W 2% 24773-275H R19 RES MF 4K7 1/4W 2% 24773-289W R20 RES MF 51R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-257W R22 RES MF 51R 1/4W 2% 24773-242Z R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-273A R27 RES MF 470R 1/4W 2% 24773-265M R28 RES MF 470R 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R34 RES MF 10K 1/4W 2% 24773-297M R35 RES MF 10K 1/4W 2% 24773-297M R37 RES MF 10K 1/4W 2% 24773-297M R38 RES MF 10K 1/4W 2% 24773-297M R39 RES MF 10K 1/4W 2% 24773-297M R30 RES MF 10K 1/4W 2% 24773-297M
R19 RES MF 4K7 1/4W 2% 24773-289W R20 RES MF 51R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-257W R22 RES MF 51R 1/4W 2% 24773-242Z R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-273A R27 RES MF 470R 1/4W 2% 24773-265M R28 RES MF 4K7 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R20 RES MF 51R 1/4W 2% 24773-242Z R21 RES MF 220R 1/4W 2% 24773-257W R22 RES MF 51R 1/4W 2% 24773-242Z R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-273A R27 RES MF 470R 1/4W 2% 24773-265M R28 RES MF 4K7 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R21 RES MF 220R 1/4W 2% 24773-257W R22 RES MF 51R 1/4W 2% 24773-242Z R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1KO 1/4W 2% 24773-273A R26 RES MF 1KO 1/4W 2% 24773-273A R27 RES MF 470R 1/4W 2% 24773-265M R28 RES MF 4K7 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-242Z R30 RES MF 10K 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R22 RES MF 51R 1/4W 2% 24773-242Z R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1KO 1/4W 2% 24773-273A R26 RES MF 1KO 1/4W 2% 24773-265M R27 RES MF 470R 1/4W 2% 24773-265M R28 RES MF 4K7 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-242Z R30 RES MF 10K 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-265M R27 RES MF 470R 1/4W 2% 24773-265M R28 RES MF 4K7 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-242Z R30 RES MF 10K 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R23 RES CC 51R 1/8W 5% 24331-989P R24 RES CC 270R 1/8W 5% 24331-992P R25 RES MF 1K0 1/4W 2% 24773-273A R26 RES MF 1K0 1/4W 2% 24773-265M R27 RES MF 470R 1/4W 2% 24773-265M R28 RES MF 4K7 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-242Z R30 RES MF 10K 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R25 RES MF 1KO 1/4W 2% 24773-273A R26 RES MF 1KO 1/4W 2% 24773-273A R27 RES MF 470R 1/4W 2% 24773-265M R28 RES MF 4K7 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-242Z R30 RES MF 10K 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R26 RES MF 1K0 1/4W 2% 24773-273A R27 RES MF 470R 1/4W 2% 24773-265M R28 RES MF 4K7 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-242Z R30 RES MF 10K 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R27 RES MF 470R 1/4W 2% 24773-265M R28 RES MF 4K7 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-242Z R30 RES MF 10K 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-297M R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R28 RES MF 4K7 1/4W 2% 24773-289W R29 RES MF 51R 1/4W 2% 24773-242Z R30 RES MF 10K 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-289W R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R29 RES MF 51R 1/4W 2% 24773-242Z R30 RES MF 10K 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-289W R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M 24773-297M
R30 RES MF 10K 1/4W 2% 24773-297M R31 RES MF 4K7 1/4W 2% 24773-289W R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R31 RES MF 4K7 1/4W 2% 24773-289W R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R32 RES MF 10K 1/4W 2% 24773-297M R33 RES MF 10K 1/4W 2% 24773-297M
R34 RES MF 51R 1/4W 2% 24773-242Z
R35 RES MF 10K 1/4W 2% 24773-297M
R36 RES MF 680R 1/4W 2% 24773-269K
R37 RES MF 1K5 1/4W 2% 24773-277U
R38 RES MF 1K5 1/4W 2% 24773-277U
R39 RES MF 1K5 1/4W 2% 24773-277U R40 RES MF 1K0 1/4W 2% 24773-273A
R41 RES MF 91R 1/4W 2% 24773-248L R42 RES MF 1K5 1/4W 2% 24773-277U
R43 RES MF 2K7 1/4W 2% 24773-283L
R44 RES MF 3KO 1/4W 2% 24773-284J
R45 RES MF 5K6 1/4W 2% 24773-291S
R46 RES MF 330R 1/4W 2% 24773-261D
R47 RES MF 1KO 1/4W 2% 24773-273A
R48 RES MF 3KO 1/4W 2% 24773-284J
R49 RES MF 5K6 1/4W 2% 24773-291S
R50 RES MF 330R 1/4W 2% 24773-261D

Circuit Ref	Description	Part Number
Unit AB2	- DIVIDE-BY-TWO CHAIN AND FM DRIVE	(Contd.)
R51 R52 R53 R54 R55	RES MF 1K2 1/4W 2% RES MF 3K0 1/4W 2% RES MF 5K6 1/4W 2% RES MF 330R 1/4W 2% RES MF 51R 1/4W 2%	24773-275H 24773-284J 24773-291S 24773-261D 24773-242Z
R56 R57 R58 R59 R61	RES MF 1KO 1/4W 2% RES MF 900R 1/4W 0.25% RES MF 3K78 0.25W 0.25% RES MF 75RO 1/4W 0.25% RES MF 4K7 1/4W 2%	24773-273A 24732-270N 24732-267N 24732-313V 24773-289W
R62 R63 R64 R65 R66	RES MF 150R 1/4W 2% RES MF 4K7 1/4W 2% RES MF 150R 1/4W 2% RES MF 4K7 1/4W 2% RES MF 150R 1/4W 2%	24773-253F 24773-289W 24773-253F 24773-289W 24773-253F
R67 R68	RES MF 2K2 1/4W 2% RES MF 2K2 1/4W 2%	24773-281Y 24773-281Y
RLA RLB RLC	RELAY REED 1CO 12V 890R RELAY REED 1CO 12V 890R RELAY REED 1CO 12V 890R	23486-427A 23486-427A 23486-427A
SKBW SKBX	CON RF SMB MALE 50 PCB STR CON RF SMB MALE 50 PCB STR	23444-334Y 23444-334Y
TR1 TR2 TR3 TR4 TR5	TRANS NPN SIL BFR90 15V TRANS NPN SIL BFR90 15V TRANS PNP SIL BC308 25V TRANS NPN SIL BFR90 15V TRANS PNP SIL BC308 25V	28452-167U 28452-167U 28433-455R 28452-167U 28433-455R
TR6 TR7 TR8 TR9 TR10	TRANS NPN SIL BFR90 15V TRANS NPN SIL BFR90 15V TRANS NPN SIL BFR90 15V TRANS NPN SIL ZTX109CL 20V TRANS PNP SIL BC308 25V	28452-167U 28452-167U 28452-167U 28452-771P 28433-455R
TR11 TR12 TR13 TR14 TR15	TRANS PNP SIL BC308 25V TRANS NPN SIL 2N2369 15V TRANS PNP SIL BFR99 25V TRANS NPN SIL ZTX109CL 20V TRANS NPN SIL ZTX109CL 20V	28433-455R 28452-197H 28433-336F 28452-771P 28452-771P
TR16	TRANS NPN SIL ZTX109CL 20V	28452-771P

Circuit Ref	Description	Part Number
Unit AB3	- ÒSCILLATORS BOARD	Issue 7
13. When	ordering, prefix circuit reference with AE	33
	Complete unit	44828-431T
C1 C2 C3 C4 C5	CAP CER 100PF 63V 2% PLATE CAP TANT .47UF 35V 20% BEAD CAP CER 2.7PF 63V .5PF PLATE CAP CER 22PF 50V 5% CHIP CAP CER 33PF 50V 5% CHIP	26343-477V 26486-207L 26343-458B 26343-781N 26343-777Y
C6 C7 C8 C9 C10	CAP CER 33PF 50V 5% CHIP CAP CER .001UF 63V 10% PLATE CAP TANT .47UF 35V 20% BEAD CAP CER .039UF 50V 20% CHIP CAP CER .039UF 50V 20% CHIP	26343-777Y 26383-585M 26486-207L 26386-493F 26386-493F
C11 C12 C13 C14 C15	CAP CER .001UF 63V 10% PLATE CAP CER 33PF 50V 5% CHIP CAP CER 22PF 50V 5% CHIP CAP CER 22PF 50V 5% CHIP CAP CER .001UF 63V 10% PLATE	26383-585M 26343-777Y 26343-781N 26343-781N 26383-585M
C16 C18 C19 C20 C21	CAP CER .001UF 63V 10% PLATE CAP CER .039UF 50V 20% CHIP CAP CER 2.2PF 63V .5PF PLATE CAP CER 5.6PF 63V .5PF PLATE CAP CER 68PF 50V 5% CHIP	26383-585M 26386-493F 26343-457R 26343-462K 26343-782L
C22 C23 C24 C25 C26	CAP CER 47PF 50V 5% CHIP CAP CER 47PF 50V 5% CHIP CAP CER .001UF 63V 10% PLATE CAP CER .039UF 50V 20% CHIP CAP CER .039UF 50V 20% CHIP	26343-780Y 26343-780Y 26383-585M 26386-493F 26386-493F
C27 C28 C29 C30 C31	CAP CER .001UF 63V 10% PLATE CAP CER 33PF 50V 5% CHIP CAP CER 22PF 50V 5% CHIP CAP CER 22PF 50V 5% CHIP CAP CER 3.3PF 63V .5PF PLATE	26383-585M 26343-777Y 26343-781N 26343-781N 26343-459K
C32 C33 C37	CAP CER .039UF 50V 20% CHIP CAP CER .001UF 63V 10% PLATE CAP TANT .47UF 35V 20% BEAD	26386-493F 26383-585M 26486-207L
D1 D3 D4 D6 D7	DIODE VAR CAP BB809 3V 29PF DIODE SIL BA482 35V JUNC DIODE SIL BA482 35V JUNC DIODE VAR CAP BB809 3V 29PF DIODE VAR CAP BB809 3V 29PF	28381-132G 28335-675R 28335-675R 28381-132G 28381-132G
D9	DIODE VAR CAP BB405 28V	28381-101V

Circuit Ref	Description	Part Number
Unit AB3	- OSCILLATORS BOARD	(Contd.)
D10 D11 D12 D13 D15	DIODE SIL BA482 35V JUNC DIODE SIL BA482 35V JUNC DIODE SIL BA482 35V JUNC DIODE VAR CAP BB809 3V 29PF DIODE SIL 1N4148 100V JUNC	28335-675R 28335-675R 28335-675R 28381-132G 28336-676J
L1 L2 L3 L4	RF COIL 10UH 4T RF COIL 10UH 4T PRINTED COIL PRINTED COIL	44290-805W 44290-805W
L5	RF COIL 10UH 4T	44290-805W
L6 L7 L8 L9 L10	RF COIL 10UH 4T RF COIL 10UH 4T RF COIL 10UH 4T PRINTED COIL PRINTED COIL	44290-805W 44290-805W 44290-805W
L11 L12	RF COIL 10UH 4T RF COIL 10UH 4T	44290-805W 44290-805W
R1 R2 R3 R4 R5	RES MF 50R 1/4W 0.25% RES MF 5K6 1/4W 2% RES MF 470R 1/4W 2% RES CHIP 22R 5% RES MF 330R 1/4W 2%	24723-388Y 24773-291S 24773-265M 24681-044U 24773-261D
R6 R7 R8 R9 R10	RES MF 470R 1/4W 2% RES MF 10K 1/4W 2% RES MF 10K 1/4W 2% RES CHIP 22R 5% RES MF 330R 1/4W 2%	24773-265M 24773-297M 24773-297M 24681-044U 24773-261D
R11 R12 R13 R14 R15	RES MF 470R 1/4W 2% RES MF 100R 1/4W 2% RES MF 10K 1/4W 2% RES MF 200R 1/4W 2% RES MF 470R 1/4W 2%	24773-265M 24773-249J 24773-297M 24773-256S 24773-265M
R16 R17 R18 R19 R20	RES MF 620R 1/4W 2% RES CC 33R 1/8W 5% RES MF 250R 1/4W 0.25% RES CHIP 22R 5% RES MF 330R 1/4W 2%	24773-268B 24331-978J 24723-389N 24681-044U 24773-261D
R21 R22 R23 R24 R25	RES MF 390R 1/4W 2% RES MF 10K 1/4W 2% RES MF 10K 1/4W 2% RES CHIP 22R 5% RES MF 330R 1/4W 2%	24773-263P 24773-297M 24773-297M 24681-044U 24773-261D
R26	RES MF 270R 1/4W 2%	24773-259T

Circuit Ref	Description	Part Number
Unit AB3	- OSCILLATORS BOARD	(Contd.)
R27 R28 R29 R30	RES MF 820R 1/4W 2% RES CC 51R 1/8W 5% RES CHIP 10R 5% RES CHIP 10R 5%	24773-271B 24331-989P 24681-042H 24681-042H
R31 R32 R35 R36	RES CHIP 10R 5% RES CHIP 10R 5% RES MF 100R 1/4W 2% RES CC 100R 1/8W 5%	24681-042H 24681-042H 24773-249J 24331-997B
TR1 TR2 TR4 TR6 TR7	TRANS FET 2N4858 40V TRANS NPN SIL BFR91 12V TRANS NPN SIL BFR91 12V TRANS NPN SIL BFR90 15V TRANS NPN SIL BFR91 12V	28459-037F 28451-696U 28451-696U 28452-167U 28451-696U
TR9 TR11	TRANS NPN SIL BFR91 12V TRANS NPN SIL BFR90 15V	28451-696U 28452-167U
Unit AB4	- O/P PHASE DETECTOR	Issue 5
14. When	ordering, prefix circuit reference with	AB4
	Complete unit	44828-432P
C1 C2 C3 C4 C5	CAP TANT 4.7UF 35V 20% BEAD CAP TANT 4.7UF 35V 20% BEAD CAP TANT 4.7UF 35V 20% BEAD CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC	26486-219P 26486-219P 26486-219P 26383-055L 26383-055L
C6 C7 C8 C9 C10	CAP CER 0.01UF 100V 20% DISC	26383-055L 26383-055L 26383-055L 26383-055L 26383-055L
C11 C12 C13 C14 C15	CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP PETP 0.68UF 100V 10% CAP PETP 5.6UF 63V 10% CAP TANT 4.7UF 35V 20% BEAD	26383-055L 26383-055L 26582-216E 26582-423E 26486-219P
C16 C17 C18	CAP CER 47PF 63V 5% PLATE CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC	26343-473L 26383-055L 26383-055L

Circuit Ref	Description	Part Number
Unit AB4	- O/P PHASE DETECTOR	(Contd.)
C19 C20 C21 C22 C23	CAP CER 0.01UF 100V 20% DISC CAP TANT 4.7UF 35V 20% BEAD CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP CER 220PF 63V 2% PLATE	26383-055L 26486-219P 26383-055L 26383-055L 26343-481S
D1 D2 D3 D4	DIODE ZENER BZY88C6V2 6.2V 5%	28371-483P 28371-483P 28371-483P 28371-483P
IC1 IC2 IC3 IC4 IC5	ICD FF D 74LS74 DUAL +EDG TR ICA VREG- LM304H PROG 0A025 ICD CTR 74LS390 DUAL 4BIT DEC ICD AND/OR 74LS51 DUAL 2-3INP ICD FF D 74LS74 DUAL +EDG TR	28462-611A 28461-723R 28464-127R 28466-454N 28462-611A
IC6 IC7 IC8	ICD NAND 74LS00 QUAD 2INP ICA VREG+ LM376N PROG 0A045 ICA ARRAY CA3046 5 NPN TRAN	28466-345H 28461-725K 28461-901A
PLBY PLBZ PLCB PLCC	CON PART PCB POST SQUARE PIN	23435-188V 23435-188V 23435-188V 23435-188V
R1 R2 R3 R4 R5	RES MF 820R 1/4W 2% RES MF 2K4 1/4W 2%	24773-271B 24773-271B 24773-271B 24773-271B 24773-282N
R6 R7 R8 R9 R10	RES MF 5K6 1/4W 2% RES MF 15R 1/4W 2% RES MF 10K 1/4W 2% RES MF 62K 1/4W 2% RES MF 100K 1/4W 2%	24773-291S 24773-229X 24773-297M 24773-316Y 24773-321L
R11 R12 R13 R14 R15	RES MF 4K7 1/4W 2% RES MF 4K7 1/4W 2% RES MF 10K 1/4W 2% RES MF 62K 1/4W 2% RES MF 47K 1/4W 2%	24773-289W 24773-289W 24773-297M 24773-316Y 24773-313H
R16 R17 R18 R19 R20	RES MF 100K 1/4W 2% RES MF 1K3 1/4W 2% RES MF 1K8 1/4W 2% RES MF 5K6 1/4W 2% RES MF 430R 1/4W 2%	24773-321L 24773-276E 24773-279N 24773-291S 24773-264X
R21 R22	RES MF 2KO 1/4W 2% RES MF 100R 1/4W 2%	24773-280U 24773-249J

Circuit Ref	Description	Part Number
Unit AB4	- O/P PHASE DETECTOR	(Contd.)
R23	RES MF 100R 1/4W 2%	24773-249J
R24	RES MF 10K 1/4W 2%	24773-297M
R25	RES MF 4K7 1/4W 2%	24773-289W
R26	RES MF 5K6 1/4W 2%	24773-2918
R27	RES MF 430R 1/4W 2%	24773-264X
R28	RES MF 2KO 1/4W 2%	24773-280U
R29	RES MF 5K6 1/4W 2%	24773-2918
R30	RES MF 430R 1/4W 2%	24773-264X
R31	RES MF 100K 1/4W 2%	24773-321L
R32	RES MF 1K3 1/4W 2%	24773-276E
R33	RES MF 1K8 1/4W 2%	24773-279N
R34	RES MF 1KO 1/4W 2%	24773-273A
R35	RES MF 1KO 1/4W 2%	24773-273A
R36	RES MF 10K 1/4W 2%	24773-297M
R37	RES MF 4K7 1/4W 2%	24773-289W
R38	RES MF 5K6 1/4W 2%	24773-2918
R39	RES MF 430R 1/4W 2%	24773-264X
R40	RES MF 100K 1/4W 2%	24773-321L
R41	RES MF 390R 1/4W 2%	24773-263P
R42	RES MF 3K9 1/4W 2%	24773-287V
R43	RES MF 1KO 1/4W 2%	24773-273A
R44	RES MF 4K7 1/4W 2%	24773-289W
R45	RES MF 10R 1/4W 2%	24773-225W
R46	RES MF 12K 1/4W 2%	24773-299R
R47	RES MF 2K2 1/4W 2%	24773-281Y
R49	RES MF 1MO 1/4W 2%	24773-346E
R50	RES MF 10K 1/4W 2%	24773-297M
R51	RES MF 10K 1/4W 2%	24773-297M
R52	RES MF 10K 1/4W 2%	24773-297M
R53	RES MF 10K 1/4W 2%	24773-297M
R54	RES MF 100R 1/4W 2%	24773 - 249J
TR1	TRANS PNP SIL BC308 25V	28433-455R
TR2	TRANS PNP SIL BC308 25V	28433-455R
TR3	TRANS PNP SIL BC308 25V	28433-455R
TR4	TRANS PNP SIL BC308 25V	28433-455R
TR9	TRANS PNP SIL BC308 25V	28433-455R
TR10	TRANS PNP SIL BC308 25V	28433-455R
TR11	TRANS NPN SIL ZTX109CL 20V	28452-771P
TR12	TRANS NPN SIL ZTX109CL 20V	28452-771P
TR13	TRANS PNP SIL BC308 25V	28433-455R
TR14	TRANS PNP SIL BFR99 25V	28433-336F
TR15	TRANS PNP SIL BFR99 25V	28433-336F
TR16	TRANS NPN SIL ZTX109CL 20V	28452-771P
TR17	TRANS NFN SIL ZTX109CL 20V	28452-771P

Circuit Ref	Description	Part Number
Unit AB4	- O/P PHASE DETECTOR	(Contd.)
TR18 TR19	TRANS NPN SIL ZTX109CL 20V TRANS PNP SIL BC308 25V	28452-771P 28433-455R
TR20 TR21 TR22 TR23 TR24	TRANS PNP SIL BFR99 25V TRANS PNP SIL BFR99 25V TRANS NPN SIL ZTX109CL 20V TRANS NPN SIL ZTX109CL 20V TRANS FET J310 25V	28433-336F 28433-336F 28452-771P 28452-771P 28459-028E
TR25 TR26	TRANS FET J310 25V TRANS FET J310 25V	28459-028E 28459-028E
Unit AB5	- VCXO LOOP	Issue 3
15. When	ordering, prefix circuit reference wit	th AB5
	Complete unit	44828-433X
C1 C2 C3 C4 C5	CAP PETP 1.0UF 100V 10% CAP PETP 0.22UF 100V 10% CAP PS 100PF 350V 2PF CAP PS 100PF 350V 2PF CAP CER 0.01UF 100V 20% DISC	26582-217U 26582-226G 26516-243J 26516-243J 26383-055L
C6 C7 C8 C9	CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC	26383-055L 26383-055L 26383-055L 26383-055L
C11 C12 C13 C14 C15	CAP CER .001UF 63V 10% PLATE CAP CER 0.01UF 100V 20% DISC	26383-585M 26383-055L 26383-055L 26383-055L 26383-055L
C17 C18 C19 C20 C21	CAP PETP 0.22UF 100V 10% CAP CER 0.01UF 100V 20% DISC CAP CER .001UF 63V 10% PLATE CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC	26582-226G 26383-055L 26383-585M 26383-055L 26383-055L
C22 C23	CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC	26383-055L 26383-055L

Circuit Ref	Description	Part Number
Unit AB5	- VCXO LOOP	(Contd.)
C24 C25 C26 C27 D1 D2 D3 D4	CAP PS 100PF 350V 2PF CAP CER 0.01UF 100V 20% DISC CAP CER .001UF 63V 10% PLATE CAP CER 220PF 63V 2% PLATE DIODE ZENER BZY88C12 12V 5% DIODE VAR CAP BB809 3V 29PF DIODE HOT CARR 1N5390 DIODE ZENER BZY88C3V6 3.6V 5%	26516-243J 26383-055L 26383-585M 26343-481S 28372-143U 28381-132G 28349-005Z 28371-223Z
IC1 IC2 IC3 IC4 IC5	ICD NOR 74LSO2 QUAD 2INP ICA MOD/DMOD MC1496N BAL DIL14 ICD CTR 74LS390 DUAL 4BIT DEC ICD FF D 74LS74 DUAL +EDG TR ICA COMP LM311N DIL8	28466-214Y 28461-924X 28464-127R 28462-611A 28461-695U
IC6 IC7	ICD NAND 74LS20 DUAL 4INP ICA AMP TL071CP FET I/P DIL8	28466-347U 28461-347A
L1 L2	IND CHOKE 15UH 5% IND CHOKE 1.5UH 10%	23642-469A 23642-550Y
PLCD PLCE PLCF	CON PART PCB POST SQUARE PIN CON PART PCB POST SQUARE PIN CON PART PCB POST SQUARE PIN	23435-188V 23435-188V 23435-188V
R1 R2 R3 R4 R5	RES MF 150R 1/4W 2% RES MF 10K 1/4W 2% RES MF 10K 1/4W 2% RES MF 10K 1/4W 2% RES MF 1KO 1/4W 2%	24773-253F 24773-297M 24773-297M 24773-297M 24773-273A
R6 R7 R8 R9 R10	RES MF 2KO 1/4W 2% RES MF 2KO 1/4W 2% RES MF 2KO 1/4W 2% RES MF 15K 1/4W 2% RES MF 12K 1/4W 2%	24773-280U 24773-280U 24773-280U 24773-301P 24773-299R
R11 R12 R13 R14 R15	RES MF 1KO 1/4W 2% RES MF 150R 1/4W 2% RES MF 300R 1/4W 2% RES MF 3K9 1/4W 2% RES MF 3K9 1/4W 2%	24773-273A 24773-253F 24773-260W 24773-287V 24773-287V
R16 R17 R18 R19 R20	RES MF 12K 1/4W 2% RES MF 10K 1/4W 2% RES MF 2K4 1/4W 2% RES MF 68R 1/4W 2% RES MF 1K0 1/4W 2%	24773-299R 24773-297M 24773-282N 24773-245U 24773-273A
R21 R22 R23	RES MF 1KO 1/4W 2% RES MF 1K5 1/4W 2% RES MF 1K5 1/4W 2%	24773-273A 24773-277U 24773-277U

Circuit Ref	Description	Part Number
Unit AB5	- VCXO LOOP	(Contd.)
R24	RES MF 8K2 1/4W 2%	24773-295P
R25	RES MF 2K4 1/4W 2%	24773-282N
R26	RES MF 1KO 1/4W 2%	24773-273A
R27	RES MF 1KO 1/4W 2%	24773-273A
R28	RES MF 39K 1/4W 2%	24773-311A
R29	RES MF 8K2 1/4W 2%	24773-295P
R30	RES MF 300R 1/4W 2%	24773-260W
R31	RES MF 300R 1/4W 2%	24773-260W
R33 R35	RES MF 3K9 1/4W 2% RES MF 2K0 1/4W 2%	24773-287V 24773-280U
R36	RES MF 10K 1/4W 2%	24773-297M
R37	RES MF 10K 1/4W 2%	24773-297M
TR1	TRANS NPN SIL ZTX109CL 20V	28452-771P
TR2	TRANS NPN SIL ZTX109CL 20V	28452-771P
TR3	TRANS NPN SIL ZTX109CL 20V	28452-771P
TR4	TRANS PNP SIL BC308 25V	28433-455R
TR5	TRANS PNP SIL BC308 25V	28433-455R
TR6	TRANS PNP SIL BC308 25V	28433-455R
TR7	TRANS NPN SIL ZTX109CL 20V	28452-771P
TR8	TRANS NPN SIL ZTX109CL 20V	28452-771P
770 4		
XL1	CRYSTAL 10.01MHZ FLYING LEADS	28312-072R
Unit ACO	- RF BOX 2 (44990-352S)	Issue 3
16. When	ordering, prefix circuit reference with	ACO
C1	CAP CER .001UF 300V 20%+ LD/T	26373-733K
C2	CAP CER .001UF 300V 20%+ LD/T	26373-733K
C3	CAP CER .001UF 300V 20%+ LD/T	26373-733K
C4	CAP CER .001UF 300V 20%+ LD/T	26373-733K
C5	CAP CER .001UF 300V 20%+ LD/T	26373 – 733K
C6	CAP CER .001UF 300V 20%+ LD/T	26373-733K
C7	CAP CER .001UF 300V 20%+ LD/T	26373-733K
C8	CAP CER .001UF 300V 20%+ LD/T	26373-733K
C9 C10	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K
	CAL CER . 00 IOF 3004 2084 ED/1	20313=133K
C11	CAP CER .001UF 300V 20%+ LD/T	26373 - 733K

Circuit	Description	Part Number
Unit ACO	- RF BOX 2	(Contd.)
C12 C13	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K
C14 C15	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K
C16 C17 C18	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K
C19 C20	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K
C21 C22 C23	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K
C24 C25	CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K
C26 C27 C28 C29 C30	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C31 C32 C33 C34 C35	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C36 C37 C38 C39 C40	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C41 C42 C43 C44 C45	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C46 C47 C48 C49 C50	CAP CER .001UF 300V 20%+ LD/T	26373-733K 26373-733K 26373-733K 26373-733K 26373-733K
C51 C52 C53 C54	CAP CER .001UF 300V 20%+ LD/T CAP CER 50PF 300V 10% LD/T CAP CER .001UF 300V 20%+ LD/T CAP CER .001UF 300V 20%+ LD/T	26373-733K 26333-229U 26373-733K 26373-733K

Circuit Ref	Description	Part Number
Unit ACO	- RF BOX 2	(Contd.)
L1 L2 L3 L4 L5	IND CHOKE 100UH 10%	23642-561W 23642-561W 23642-561W 23642-561W 23642-561W
L6 L7 L8 L9 L10	IND CHOKE 100UH 10%	23642-561W 23642-561W 23642-561W 23642-561W 23642-561W
L11 L12 L13 L14 L15	IND CHOKE 100UH 10%	23642-561W 23642-561W 23642-561W 23642-561W 23642-561W
L16 L17 L18 L19 L20	IND CHOKE 100UH 10%	23642-561W 23642-561W 23642-561W 23642-561W 23642-561W
L21 L22 L23 L24 L34	IND CHOKE 100UH 10%	23642-561W 23642-561W 23642-561W 23642-561W 23642-561W
PLDE	CONN ASSY PLDE	43129-687T
SKAW SKAX SKCM SKCN SKCP	CON RF SMB MALE 50 BKHD SOLDER CON RF SMC MALE 50 BKHD SOLDER CONN ASSY SKCM CONN ASSY SKCN-SKDC CONN ASSY SKCP-SKCZ	23444-331H 23444-382T 43129-680J 43129-683V 43129-682G
SKCR SKCU	CONN ASSY SKCR	43129-681F 43129-685W
SKCV SKDA SKDD	CONN ASSY SKCV CONN ASSY SKDA-SKCT-SKCW CONN ASSY SKDD	43129-686D 43129-684S 43129-688P
X3 X4 X5	FERRITE BEAD FERRITE BEAD FERRITE BEAD	41372-006T 41372-006T 41372-006T

Circuit Ref	Description	Part Number
Unit AC2	- B.F.O. SYSTEM	Issue 3
17. When	ordering, prefix circuit reference with	AC2
	Complete unit	44828-435C
C1 C2 C3 C4 C5	CAP CER 0.01UF 100V 20% DISC CAP CER 560PF 63V 10% PLATE	26383-055L 26383-055L 26383-055L 26383-055L 26383-581D
C6 C7 C8 C9 C10	CAP CER 100PF 63V 2% PLATE CAP CER .001UF 63V 10% PLATE CAP CER 560PF 63V 10% PLATE CAP TANT .47UF 35V 20% BEAD .CAP CER 0.01UF 100V 20% DISC	26343-477V 26383-585M 26383-581D 26486-207L 26383-055L
C11 C12 C13 C14 C15	CAP CER 0.01UF 100V 20% DISC CAP TANT .47UF 35V 20% BEAD CAP TANT .47UF 35V 20% BEAD CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC	26383-055L 26486-207L 26486-207L 26383-055L 26383-055L
C16 C17 C18 C19 C20	CAP CER 0.01UF 100V 20% DISC CAP CER 560PF 63V 10% PLATE CAP CER .001UF 63V 10% PLATE CAP CER 100PF 63V 2% PLATE CAP CER 560PF 63V 10% PLATE	26383-055L 26383-581D 26383-585M 26343-477V 26383-581D
C21 C22 C23	CAP TANT .47UF 35V 20% BEAD CAP TANT .47UF 35V 20% BEAD CAP TANT .47UF 35V 20% BEAD	26486-207L 26486-207L 26486-207L
D1 D2	DIODE SIL BA482 35V JUNC DIODE SIL BA482 35V JUNC	28335-675R 28335-675R
L1 L2 L3 L4 L5	IND CHOKE 15UH 10% IND CHOKE 15UH 10% IND CHOKE 15UH 10% IND CHOKE 15UH 10% IND CHOKE 1000UH 10%	23642-556V 23642-556V 23642-556V 23642-556V 23642-567C
PLCU PLCV PLCW	CON PART PCB POST SQUARE PIN CON PART PCB POST SQUARE PIN CON PART PCB POST SQUARE PIN	23435-188V 23435-188V 23435-188V

Circuit Ref	Description	Part Number
Unit AC2	- B.F.O. SYSTEM	(Contd.)
R1 R2 R3 R4 R5	RES MF 51R 1/4W 2% RES MF 10K 1/4W 2% RES MF 10K 1/4W 2% RES MF 270R 1/4W 2% RES MF 470R 1/4W 2%	24773-242Z 24773-297M 24773-297M 24773-259T 24773-265M
R6 R7 R8 R9 R10	RES MF 18R 1/4W 2% RES MF 10K 1/4W 2% RES MF 10K 1/4W 2% RES MF 1K8 1/4W 2% RES MF 220R 1/4W 2%	24773-231P 24773-297M 24773-297M 24773-279N 24773-257W
R11 R12 R13 R14 R15	RES MF 680R 1/4W 2% RES MF 51R 1/4W 2% RES MF 560R 1/4W 2% RES MF 91R 1/4W 2% RES MF 10K 1/4W 2%	24773-269K 24773-242Z 24773-267R 24773-248L 24773-297M
R16 R17 R18 R19 R20	RES MF 1K5 1/4W 2% RES MF 220R 1/4W 2% RES MF 1K0 1/4W 2% RES MF 330R 1/4W 2% RES MF 1K0 1/4W 2%	24773-277U 24773-257W 24773-273A 24773-261D 24773-273A
TR1 TR2 TR3	TRANS NPN SIL 2N2369 15V TRANS NPN SIL 2N2369 15V TRANS NPN SIL 2N2369 15V	28452-197H 28452-197H 28452-197H
T1	CORE BEAD .079X.158X.197LG	23635-833X

Circuit	Description	Par Numbe	
Unit AC	3 - FILTER BOARD (2018 only)	Issue 7	
18 W	hen ordering, prefix circuit reference with	AC3	
	Complete unit	44828-43	6R
C1 C2 C3 C4 C5	CAP CER .039UF 50V 20% CHIP CAP CER 0.01UF 100V 20% DISC CAP CER .039UF 50V 20% CHIP CAP CER .039UF 50V 20% CHIP CAP CER .039UF 50V 20% CHIP	26386-493 26386-493 26386-493 26386-493	5L 3F 3F
C6 C7 C8 C9 C10	CAP CER .039UF 50V 20% CHIP CAP CER 0.01UF 100V 20% DISC	26386-49 26386-49 26386-49 26383-05	3F 3F 3F
C11 C12 C13 C14 C15	CAP CER 0.047UF 25V 20% DISC CAP CER 0.01UF 100V 20% DISC	26383-01 ⁹ 26383-05 ⁹ 26383-05 ⁹ 26383-05 ⁹ 26383-05 ⁹	5L 5L 5L
C16 C18 C19 C20 C21	CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP CER 8.2PF 63V .5PF PLATE CAP CER 12PF 63V 5% PLATE	26383-059 26383-059 26383-059 26343-469 26343-469	5L 5L 4Z
C22 C23 C24 C25 C26	CAP CER 8.2PF 63V .5PF PLATE CAP CER .001UF 63V 10% PLATE	26343-46 26383-58 26383-58 26383-58 26383-58	5M 5M 5M
C27 C28 C29 C30 C31	CAP CER .001UF 63V 10% PLATE CAP CER 6.8PF 63V .5PF PLATE CAP CER 18PF 63V 5% PLATE CAP CER 22PF 63V 5% PLATE CAP CER 18PF 63V 5% PLATE	26383-58 26343-46 26343-46 26343-46 26343-46	3A 8Y 9N
C32 C33 C34 C35 C36	CAP CER 22PF 63V 5% PLATE CAP CER 33PF 63V 5% PLATE CAP CER 22PF 63V 5% PLATE CAP CER 33PF 63V 5% PLATE CAP CER 47PF 63V 5% PLATE	26343-46 26343-46 26343-46 26343-47 26343-47	1Y 9N 1Y
C37 C38 C39 C40 C41	CAP CER 33PF 63V 5% PLATE CAP CER 47PF 63V 5% PLATE CAP CER 68PF 63V 2% PLATE CAP CER 47PF 63V 5% PLATE CAP CER 68PF 63V 2% PLATE	26343-47 26343-47 26343-47 26343-47 26343-47	3L 5F 3L

Circuit Ref	Description	Part Number
Unit AC3	- FILTER BOARD	(Contd.)
C42 C43 C44 C45 C46	CAP CER 100PF 63V 2% PLATE CAP CER 68PF 63V 2% PLATE CAP CER 82PF 63V 2% PLATE CAP CER 150PF 63V 2% PLATE CAP CER 82PF 63V 2% PLATE	26343-477V 26343-475F 26343-476G 26343-479W 26343-476G
C47 C48 C49 C50 C51	CAP CER .001UF 63V 10% PLATE CAP CER 12PF 63V 5% PLATE	26383-585M 26383-585M 26383-585M 26383-585M 26343-466E
C52 C53 C54 C55 C56	CAP CER 18PF 63V 5% PLATE CAP CER 12PF 63V 5% PLATE CAP CER .001UF 63V 10% PLATE CAP CER 1.8PF 63V .5PF PLATE CAP CER .001UF 63V 10% PLATE	26343-468Y 26343-466E 26383-585M 26343-456C 26383-585M
C58 C59 C60 C61 C62	CAP CER .001UF 63V 10% PLATE CAP CER 0.01UF 100V 20% DISC	26383-585M 26383-055L 26383-055L 26383-055L
C63 C64 C65 C66 C67	CAP CER 2.2PF 63V .5PF PLATE CAP CER 100PF 63V 2% PLATE CAP CER 120PF 63V 2% PLATE CAP CER 33PF 63V 5% PLATE CAP CER 100PF 63V 2% PLATE	26343-457R 26343-477V 26343-478S 26343-471Y 26343-477V
C68 C69 C70 C71 C72	CAP CER 22PF 63V 5% PLATE CAP CER 150PF 63V 2% PLATE CAP CER 180PF 63V 2% PLATE CAP CER 150PF 63V 2% PLATE CAP CER 22PF 63V 5% PLATE	26343-469N 26343-479W 26343-480V 26343-479W 26343-469N
C73 C74 C75 C76 C77	CAP CER 180PF 63V 2% PLATE CAP CER 270PF 63V 2% PLATE CAP CER 180PF 63V 2% PLATE CAP CER 270PF 63V 2% PLATE CAP CER 390PF 63V 10% PLATE	26343-480V 26343-482W 26343-480V 26343-482W 26383-598Y
C78 C79 C80 C81 C82	CAP CER 270PF 63V 2% PLATE CAP CER 470PF 63V 10% PLATE CAP CER 560PF 63V 10% PLATE CAP CER 470PF 63V 10% PLATE CAP CER 560PF 63V 10% PLATE	26343-482W 26383-582T 26383-581D 26383-582T 26383-581D
C83 C84 C85	CAP CER 820PF 63V 10% PLATE CAP CER 47PF 63V 5% PLATE CAP CER 560PF 63V 10% PLATE	26383-584X 26343-473L 26383-581D

Circuit Ref	Description	Part Number
Unit AC3	- FILTER BOARD	(Contd.)
C86	CAP CER 0.01UF 100V 20% DISC	26383-055L
C87	CAP CER 0.01UF 100V 20% DISC	26383-055L
C88	CAP CER 0.01UF 100V 20% DISC	26383-055L
C89	CAP CER 0.01UF 100V 20% DISC	26383-055L
C90	CAP CER 68PF 63V 2% PLATE	26343-475F
C91	CAP CER 82PF 63V 2% PLATE	26343-476G
C92	CAP CER 68PF 63V 2% PLATE	26343-475F
C93	CAP CER 33PF 63V 5% PLATE	26343-4711
C94	CAP CER 2.2PF 63V .5PF PLATE	26343-457F
C95	CAP CER 0.01UF 100V 20% DISC	26383-055L
C96	CAP CER 47PF 63V 5% PLATE	26343-4731
C97	CAP CER 68PF 63V 2% PLATE	26343-475F
C98	CAP CER 47PF 63V 5% PLATE	26343-4731
C99	CAP CER 0.01UF 100V 20% DISC	26383-055L
C100	CAP CER 0.01UF 100V 20% DISC	26383-055L
C101	CAP CER .001UF 63V 10% PLATE	26383-585M
C102	CAP TANT 4.7UF 35V 20% BEAD	26486-219F
C103	CAP TANT 4.7UF 35V 20% BEAD	26486-2191
C104	CAP TANT 4.7UF 35V 20% BEAD	26486-219F
C132	CAP CER .001UF 63V 10% PLATE	26383-585N
C144	CAP CER 0.01UF 100V 20% DISC	26383-0551
D1	DIODE SIL BA482 35V JUNC	28335-675F
D2	DIODE SIL BA482 35V JUNC	28335-675F
D3	DIODE SIL 1N4148 100V JUNC	28336-6763
D4	DIODE SIL 1N4148 100V JUNC	28336-6763
D6	DIODE SIL BA482 35V JUNC	28335 – 675F
D7	DIODE SIL BA482 35V JUNC	28335-675F
D8	DIODE SIL BA482 35V JUNC	28335-675F
D9	DIODE SIL BA482 35V JUNC	28335-675F
D10	DIODE SIL BA482 35V JUNC	28335-675F
D11	DIODE SIL BA482 35V JUNC	28335 – 675F
D12	DIODE SIL BA482 35V JUNC	28335-675
D13	DIODE SIL BA482 35V JUNC	28335-675F
D14	DIODE SIL BA482 35V JUNC	28335-675F
D15	DIODE SIL BA482 35V JUNC	28335-675F
D16	DIODE SIL BA482 35V JUNC	28335 – 675F
D17	DIODE SIL BA482 35V JUNC	28335-6751
D18	DIODE SIL BA482 35V JUNC	28335-675F
D19	DIODE SIL BA482 35V JUNC	28335-675F
D20	DIODE SIL BA482 35V JUNC	28335-675F
D21	DIODE SIL BA482 35V JUNC	28335 – 675F
D22	DIODE SIL BA482 35V JUNC	28335-675F
D23	DIODE SIL BA482 35V JUNC	28335-6751

Circuit Ref	Description	Part Number
Unit AC3	- FILTER BOARD	(Contd.)
D24	DIODE SIL BA482 35V JUNC	28335-675R
D25	DIODE SIL BA482 35V JUNC	28335-675R
D26	DIODE SIL BA482 35V JUNC	28335-675R
D27	DIODE SIL BA482 35V JUNC	28335-675R
D28	DIODE SIL BA482 35V JUNC	28335-675R
D30	DIODE SIL BA482 35V JUNC	28335-675R
D32	DIODE SIL BA482 35V JUNC	28335-675R
D33	DIODE SIL BA482 35V JUNC	28335-675R
D34	DIODE SIL BA482 35V JUNC	28335-675R
D35	DIODE SIL BA482 35V JUNC	28335-675R
D36	DIODE SIL BA482 35V JUNC	28335-675R
D37	DIODE SIL BA482 35V JUNC	28335-675R
D38	DIODE SIL BA482 35V JUNC	28335-675R
D39	DIODE SIL BA482 35V JUNC	28335-675R
D40	DIODE SIL BA482 35V JUNC	28335-675R
D41	DIODE SIL BA482 35V JUNC	28335-675R
D42	DIODE SIL BA482 35V JUNC	28335-675R
D43	DIODE SIL BA482 35V JUNC	28335-675R
D44	DIODE SIL BA482 35V JUNC	28335-675R
D45	DIODE SIL BA482 35V JUNC	28335-675R
D46	DIODE SIL BA482 35V JUNC	28335-675R
D47	DIODE SIL BA482 35V JUNC	28335-675R
D49	DIODE SIL BA482 35V JUNC	28335-675R
D50	DIODE SIL BA482 35V JUNC	28335-675R
D51	DIODE SIL BA482 35V JUNC	28335-675R
D52	DIODE SIL BA482 35V JUNC	28335-675R
D53	DIODE SIL BA482 35V JUNC	28335-675R
D74	DIODE HOT CARR 1N5390	28349-005Z
D75	DIODE HOT CARR 1N5390	28349-005Z
IC1	ICD DEC/DMX 74LS138 3-8	28465-027F
IC2	ICD FF D 74LS273 OCT +EDG TR	28462-615U
IC3	ICD FF D 74LS273 OCT +EDG TR	28462-615U
IC4	ICD BUFF 7407 HEX O/C	28469-703X
IC5	ICD INV 7405A HEX O/C	28469-157K
L1	IND CHOKE 68UH 10%	23642 – 560S
L2	IND CHOKE 4.7UH 10%	23642 - 553J
L3	IND CHOKE 68UH 10%	23642 - 560S
L4	6-HOLE FERRITE, 2.4UH INDUCTOR	44290-790U
L5	6-HOLE FERRITE, 2.4UH INDUCTOR	44290-790U
L6	PRINTED COIL	
L7	PRINTED COIL	
L8	IND CHOKE 4.7UH 10%	23642-553J
L9	IND CHOKE 4.7UH 10%	23642-553J
61		

Circuit	Description	Part Number
Unit AC3	- FILTER BOARD	(Contd.)
L10	IND CHOKE 4.7UH 10%	23642-553J
L11 L12 L13 L14 L15	IND CHOKE 4.7UH 10% IND CHOKE 4.7UH 10% ADJ. IND. 30NH 1 3/4 T ADJ. IND. 30NH 1 3/4 T ADJ. IND. 43NH 2 1/4 T	23642-553J 23642-553J 44290-799W 44290-800J
L16 L17 L18 L19 L20	ADJ. IND. 43NH 2 1/4 T ADJ. IND. 61NH 2 3/4 T ADJ. IND. 61NH 2 3/4 T ADJ. IND. 86NH 3 3/4 T ADJ. IND. 86NH 3 3/4 T	44290-800J 44290-801F 44290-801F 44290-802G 44290-802G
L21 L22 L23 L24 L25	ADJ. IND. 121NH 4 3/4 T ADJ. IND. 121NH 4 3/4 T ADJ. IND. 172NH 6 3/4 T ADJ. IND. 172NH 6 3/4 T IND CHOKE 4.7UH 10%	44290-803V 44290-803V 44290-804S 44290-804S 23642-553J
L26 L27 L28 L30 L31	IND CHOKE 4.7UH 10% IND CHOKE 4.7UH 10% IND CHOKE 4.7UH 10% PRINTED COIL PRINTED COIL	23642 – 553J 23642 – 553J 23642 – 553J
L33 L34 L36 L37 L38	IND CHOKE 4.7UH 10% IND CHOKE 4.7UH 10% IND CHOKE 4.7UH 10% IND CHOKE 68UH 10% IND CHOKE 68UH 10%	23642-553J 23642-553J 23642-560S 23642-560S
L39 L40 L41 L42 L43	IND CHOKE 68UH 10% IND CHOKE 68UH 10% IND CHOKE 1.8UH 5% IND CHOKE 1.8UH 5% IND CHOKE 3.0UH 5%	23642-560S 23642-560S 23642-495X 23642-495X 23642-474H
L44 L45 L46 L47 L48	IND CHOKE 3.0UH 5% IND CHOKE 4.3UH 5% IND CHOKE 4.3UH 5% IND CHOKE 6.2UH 5% IND CHOKE 6.2UH 5%	23642-474H 23642-466R 23642-466R 23642-455S 23642-455S
L49 L50 L51 L52 L53	IND CHOKE 8.2UH 5% IND CHOKE 8.2UH 5% IND CHOKE 12UH 5% IND CHOKE 12UH 5% IND CHOKE 68UH 10%	23642-468K 23642-468K 23642-456W 23642-456W 23642-560S
L54 L55	IND CHOKE 68UH 10% IND CHOKE 68UH 10%	23642-560S 23642-560S

Circuit Ref	Description	Part Number
Unit AC3	- FILTER BOARD	(Contd.)
L56 L57 L58	IND CHOKE 68UH 10% IND CHOKE 68UH 10% IND CHOKE 1.5UH 5%	23642-560S 23642-560S 23642-494P
L59 L60 L61 L62 L63	IND CHOKE 1.5UH 5% IND CHOKE 68UH 10% IND CHOKE 68UH 10% IND CHOKE 68UH 10% IND CHOKE 0.82UH 5%	23642-494P 23642-560S 23642-560S 23642-454B
L64 L65 L66 L90 L91	IND CHOKE 0.82UH 5% IND CHOKE 68UH 10% IND CHOKE 68UH 10% 6-HOLE FERRITE, 2.4UH INDUCTOR RES. LEAD LENGTH	23642-454B 23642-560S 23642-560S 44290-790U
L92	RES. LEAD LENGTH	
PLCM PLCN PLCP PLCR PLCT	CON PART PCB POST SQUARE PIN	23435-188V 23435-188V 23435-188V 23435-188V 23435-188V
PLDF	CONN ASSY	43129 - 537Y
R1 R2 R3 R4 R5	RES MF 360R 1/4W 2% RES MF 1KO 1/4W 2% RES MF 470R 1/4W 2% RES MF 3KO 1/4W 2% RES MF 3KO 1/4W 2%	24773-262T 24773-273A 24773-265M 24773-284J 24773-284J
R6 R7 R8 R9 R10	RES MF 75R 1/4W 2% RES MF 1K5 1/4W 2% RES CC 150R 1/8W 5% RES CC 150R 1/8W 5% RES CHIP 16R 5%	24773-246Y 24773-277U 24331-990D 24331-990D 24681-043E
R11 R12 R13 R14 R15	RES CHIP 16R 5% RES MF 51R 1/4W 2% RES MF 51R 1/4W 2% RES MF 6K8 1/4W 2% RES MF 6K8 1/4W 2%	24681-043E 24773-242Z 24773-242Z 24773-293D 24773-293D
R16 R17 R18 R19 R20	RES MF 200R 1/4W 2% RES MF 820R 1/4W 2% RES MF 75R 1/4W 2% RES MF 2K4 1/4W 2% RES MF 820R 1/4W 2%	24773-256S 24773-271B 24773-246Y 24773-282N 24773-271B
R21 R22	RES MF 820R 1/4W 2% RES MF 3K9 1/4W 2%	24773-271B 24773-287V

Circuit	Description	Part Number
Unit AC3	- FILTER BOARD	(Contd.)
R23	RES MF 360R 1/4W 2%	24773-262T
R24	RES MF 470R 1/4W 2%	24773-265M
R25	RES MF 5K6 1/4W 2%	24773-2918
R26	RES MF 300R 1/4W 2%	24773-260W
R27	RES MF 300R 1/4W 2%	24773-260W
R28	RES MF 6K8 1/4W 2%	24773-293D
R29	RES MF 270R 1/4W 2%	24773-259T
R30	RES MF 240R 1/4W 2%	24773-258D
R31	RES MF 10K 1/4W 2%	24773-297M
R32	RES MF 240R 1/4W 2%	24773-258D
R33	RES MF 1KO 1/4W 2%	24773-273A
R34	RES MF 470R 1/4W 2%	24773-265M
R35	RES MF 1K5 1/4W 2%	24773-2770
R36	RES MF 470R 1/4W 2%	24773-265M
R37	RES MF 1KO 1/4W 2%	24773-273A
R38	RES MF 470R 1/4W 2%	24773-265M
R39	RES MF 1KO 1/4W 2%	24773-273A
R40	RES MF 470R 1/4W 2%	24773-265M
R42	RES MF 470R 1/4W 2%	24773-265M
R43	RES MF 680R 1/4W 2%	24773-269K
R44	RES MF 680R 1/4W 2%	24773-269K
R45	RES MF 680R 1/4W 2%	24773-269K
R46	RES MF 680R 1/4W 2%	24773-269K
R47	RES MF 1KO 1/4W 2%	24773-273A
R48	RES MF 470R 1/4W 2%	24773-265M
R50	RES MF 470R 1/4W 2%	24773-265M
R51	RES MF 1KO 1/4W 2%	24773-273A 24773-265M
R52	RES MF 470R 1/4W 2%	24//3-200M
R53	RES MF 1KO 1/4W 2%	24773-273A
R54	RES MF 1K5 1/4W 2%	24773-2770
R55	RES MF 470R 1/4W 2%	24773-265M
R56	RES MF 470R 1/4W 2%	24773-265M
R57	RES MF 470R 1/4W 2%	24773-265M
R92	RES MF 1KO 1/4W 2%	24773-273A
R93	RES MF 470R 1/4W 2%	24773-265M
SKCS	CON RF SMB MALE 50 PCB STR	23444-334Y
mp 1	TRANS NOW STI DEDOG 150	28452-171Y
TR1	TRANS NPN SIL BFR96 15V TRANS NPN SIL BFR96 15V	28452-1711 28452-1711
TR2	TRANS NPN SIL BERGO 15V TRANS NPN SIL 2N2369 15V	001100 4000
TR3	TUNNO NEW OTT SUSSOS 10A	20432-1310

Circuit Ref		Description	Part Number	
Unit	AC4	- OUTPUT AMPLIFIER	Issue 4	
19.	When	ordering, prefix circuit reference with	AC4	
		Complete unit	44828-439A	
C1 C2 C3 C4 C5		CAP CER .039UF 50V 20% CHIP CAP TANT 4.7UF 35V 20% BEAD CAP CER .001UF 63V 10% PLATE CAP CER .039UF 50V 20% CHIP CAP CER .039UF 50V 20% CHIP	26386-493F 26486-219P 26383-585M 26386-493F 26386-493F	
C6 C7 C8 C9 C10		CAP CER 2.2PF 63V .5PF PLATE CAP CER 100PF 63V 2% PLATE CAP CER .039UF 50V 20% CHIP CAP TANT 4.7UF 35V 20% BEAD CAP CER .001UF 63V 10% PLATE	26343-457R 26343-477V 26386-493F 26486-219P 26383-585M	
C11 C12 C13 C14 C15		CAP CER .039UF 50V 20% CHIP CAP CER .039UF 50V 20% CHIP CAP CER 2.2PF 63V .5PF PLATE CAP CER 100PF 63V 2% PLATE CAP CER 4.7PF 63V .5PF PLATE	26386-493F 26386-493F 26343-457R 26343-477V 26343-461B	
C16 C17 C18 C19 C20		CAP CER .001UF 63V 10% PLATE CAP TANT 4.7UF 35V 20% BEAD CAP TANT .47UF 35V 20% BEAD CAP CER .039UF 50V 20% CHIP CAP CER .039UF 50V 20% CHIP	26383-585M 26486-219P 26486-207L 26386-493F 26386-493F	
C21 C22 C23 C24 C25		CAP CER 1.8PF 63V .5PF PLATE CAP CER .039UF 50V 20% CHIP CAP CER 10PF 50V 5% CHIP CAP CER 100PF 63V 2% PLATE CAP TANT 4.7UF 35V 20% BEAD	26343-456C 26386-493F 26343-767B 26343-477V 26486-219P	
C26 C27 C28 C29 C30		CAP TANT .47UF 35V 20% BEAD CAP CER 4.7PF 63V .5PF PLATE CAP CER 4.7PF 63V .5PF PLATE CAP TANT 4.7UF 35V 20% BEAD CAP CER .1UF 50V 20%+ CHIP	26486-207L 26343-461B 26343-461B 26486-219P 26386-496S	
C31 C32 C33 C34 C35		CAP CER 4.7PF 63V .5PF PLATE CAP CER 4.7PF 63V .5PF PLATE CAP CER .01UF 100V 20% CHIP CAP CER .01UF 100V 20% CHIP CAP CER 0.01UF 100V 20% DISC	26343-461B 26343-461B 26386-494G 26386-494G 26383-055L	
C36 C37 C38 C39 C40		CAP TANT .47UF 35V 20% BEAD CAP TANT .47UF 35V 20% BEAD CAP CER 0.01UF 100V 20% DISC CAP TANT .47UF 35V 20% BEAD CAP CER 0.01UF 100V 20% DISC	26486-207L 26486-207L 26383-055L 26486-207L 26383-055L	

Circuit Ref	Description	Part Number
Unit AC4	- OUTPUT AMPLIFIER	(Contd.)
C41 C42 C43 C44 C45	CAP CER 0.01UF 100V 20% DISC CAP TANT .47UF 35V 20% BEAD CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP TANT .47UF 35V 20% BEAD	26383-055L 26486-207L 26383-055L 26383-055L 26486-207L
C46 C47 C48 C49 C50	CAP CER 0.01UF 100V 20% DISC CAP PETP 0.1UF 100V 10% CAP CER .001UF 63V 10% PLATE CAP TANT 4.7UF 35V 20% BEAD CAP TANT 4.7UF 35V 20% BEAD	26383-055L 26582-211B 26383-585M 26486-219P 26486-219P
C51 C52 C53 C54 C55	CAP TANT 4.7UF 35V 20% BEAD CAP CER 0.01UF 100V 20% DISC	26486-219P 26383-055L 26383-055L 26383-055L
C56 C57 C58 C59 C60	CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP PETP 0.01UF 400V 10% CAP CER .039UF 50V 20% CHIP CAP CER .001UF 63V 10% PLATE	26383-055L 26383-055L 26582-232W 26386-493F 26383-585M
C61 C62	CAP CER 2.2PF 63V .5PF PLATE CAP CER 1.8PF 63V .5PF PLATE	26343-457R 26343-456C
D1 D2 D3 D4 D5	DIODE SIL 1N4448 75V JUNC DIODE PIN 5082-3379 50V DIODE SIL 1N4448 75V JUNC DIODE PIN 5082-3379 50V DIODE SIL BA482 35V JUNC	28336-246M 28383-997T 28336-246M 28383-997T 28335-675R
D6 D7 D8 D9 D10	DIODE SIL 1N4448 75V JUNC	28336-246M 28336-246M 28336-246M 28336-246M 28336-246M
D11 D12 D13 D14 D15	DIODE HOT CARR HP5082-2826 DIODE HOT CARR HP5082-2826 DIODE HOT CARR HP5082-2826 DIODE SIL 1N4448 75V JUNC DIODE SIL 1N4448 75V JUNC	28349-011U 28349-011U 28349-011U 28336-246M 28336-246M
D16 D17 D18 D19	DIODE HOT CARR HP5082-2826 DIODE HOT CARR HP5082-2826 DIODE PIN 5082-3379 50V DIODE PIN 5082-3379 50V	28349-011U 28349-011U 28383-997T 28383-997T
IC1	ICA AMP TLO74CN QUAD FET I/P	28461-349Н

Circuit Ref	Description	Part Number	
Unit AC4	- OUTPUT AMPLIFIER		(Contd.)
IC2 IC3 IC4 IC5	ICD FF D 7474 DUAL +EDG TR ICA AMP TLO74CN QUAD FET I/P ICA DAC AD7524JN 8BIT ICD INV 74LS04 HEX	1	28462-002N 28461-349H 28469-400R 28469-171L
IC6	ICA DAC AD7522LN 10BIT MOS	!	28469-402K
L1 L2 L3 L4 L5	RES. LEAD LENGTH PRINTED COIL RES. LEAD LENGTH PRINTED COIL RES. LEAD LENGTH		
L6 L7 L8 L9 L10	6-HOLE FERRITE, 2.4UH INDUCTOR PRINTED COIL IND CHOKE 1000UH 10% .18A 6-HOLE FERRITE, 2.4UH INDUCTOR 6-HOLE FERRITE, 2.4UH INDUCTOR		44290-790U 23642-620Y 44290-790U 44290-790U
L11 L12 L13	IND CHOKE 1000UH 10% IND CHOKE 1000UH 10% IND CHOKE 1000UH 10%		23642-567C 23642-567C 23642-567C
PLCS PLCZ PLDA	CONN ASSY CON PART PCB POST SQUARE PIN CON PART PCB POST SQUARE PIN		43129-668H 23435-188V 23435-188V
R1 R2 R3 R4 R5	RES MF 750R 1/4W 2% RES MF 10K 1/4W 2% RES MF 620R 1/4W 2% RES MF 2K7 1/4W 2% RES MF 33R 1/4W 2%		24773-270R 24773-297M 24773-268B 24773-283L 24773-237K
R6 R7 R8 R9 R10	RES MF 240R 1/4W 2% RES CC 200R 1/8W 5% RES CHIP 16R 5% RES CHIP 22R 5% RES MF 750R 1/4W 2%		24773-258D 24331-999A 24681-043E 24681-044U 24773-270R
R11 R12 R13 R14 R15	RES MF 10K 1/4W 2% RES MF 620R 1/4W 2% RES MF 620R 1/4W 2% RES MF 2K7 1/4W 2% RES MF 33R 1/4W 2%		24773-297M 24773-268B 24773-268B 24773-283L 24773-237K
R16 R17 R18	RES MF 240R 1/4W 2% RES CC 200R 1/8W 5% RES CHIP 16R 5%		24773-258D 24331-999A 24681-043E

Circuit Ref	Description	Part Number
Unit AC4	- OUTPUT AMPLIFIER	(Contd.)
R19	RES CHIP 22R 5%	24681-0440
R20	RES MF 620R 1/4W 2%	24773-268B
R21	RES MF 620R 1/4W 2%	24773-268B
R22	RES MF 3K3 1/4W 2%	24773-285F
R23	RES MF 10K 1/4W 2%	24773-297M
R24	RES MF 10K 1/4W 2%	24773-297M
R25	RES MF 150R 1/4W 2%	24773-253F
R26	RES CHIP 22R 5%	24681-044U
R27	RES MF 750R 1/4W 2%	24773-270R
R28	RES MF 10K 1/4W 2%	24773-297M
R29	RES MF 2K7 1/4W 2%	24773-283L
R30	RES CC 82R 1/8W 5%	24331-996R
R31	RES MF 22R 1/4W 2%	24773-233M
R32	RES MO 150R 1/2W 2%	24573-053K
R33	RES CHIP 16R 5%	24681-043E
R34	RES CHIP 16R 5%	24681-043E
R35	RES CHIP 16R 5%	24681-043E
R36	RES MF 1KO 1/4W 2%	24773-273A
R37	RES MF 15K 1/4W 2%	24773-301P
R38	RES MF 1KO 1/4W 2%	24773-273A
R39	RES MF 10R 1/4W 2%	24773-225W
R40	RES CHIP 16R 5%	24681-043E
R41	RES CHIP 16R 5%	24681-043E
R42	RES MF 200R 1/4W 2%	24773-256S
R43	RES MG 4M7 1/4W 5%	24321-881F
R44	RES MF 1KO 1/4W 2%	24773-273A
R45	RES MG 4M7 1/4W 5%	24321-881F
R46	RES MG 4M7 1/4W 5%	24321-881F
R47	RES MF 50R0 1/4W 1% N-I	24762-558R
R48	RES MF 10K 1/4W 2%	24773-297M
R49	RES MF 200R 1/4W 2%	24773-256\$
R50	RES MF 10K 1/4W 2%	24773-297M
R51	RES MF 820R 1/4W 2%	24773-271B
R52	RES MF 27R 1/4W 2%	24773-235R
R53	RES MF 10K 1/4W 2%	24773-297M
R54	RES MF 200R 1/4W 2%	24773-256\$
R55	RES MF 10K 1/4W 2%	24773-297M
R56	RES MF 10K 1/4W 2%	24773-297M
R57	RES MF 10K 1/4W 2%	24773-297M
R58	RES MF 820R 1/4W 2%	24773-271B
R59	RES MF 27R 1/4W 2%	24773-235R
R60	RES MF 10K 1/4W 2%	24773-297M
R61	RES MF 10K 1/4W 2%	24773-297M

Circuit Ref	Description	Part Number
Unit AC4	- OUTPUT AMPLIFIER	(Contd.)
R62 R63 R64 R65	RES MF 10K 1/4W 2% RES MF 1KO 1/4W 2% RES MF 200R 1/4W 2% RES MF 3K3 1/4W 2%	24773-297M 24773-273A 24773-256S 24773-285F
R66 R67 R68 R69 R70	RES MF 150R 1/4W 2% RES MF 51R 1/4W 2% RES MF 15K 1/4W 2% RES MF 30K 1/4W 2% RES MF 15K 1/4W 2%	24773-253F 24773-242Z 24773-301P 24773-308A 24773-301P
R71 R72 R73 R74 R75	RES MF 10K 1/4W 2% RES MF 3K3 1/4W 2% RES MF 10K 1/4W 2% RES MF 33K 1/4W 2% RES MF 33K 1/4W 2%	24773-297M 24773-285F 24773-297M 24773-309Z 24773-309Z
R76 R77 R78 R79 R80	RES NET 10K 5% 8DIL DIL RV CERM 1K0 LIN .5W 10% HORZ RES MF 2K0 1/4W 2% RES MF 15K 1/4W 2% RES MF 2K0 1/4W 2%	24681-511P 25711-638G 24773-280U 24773-301P 24773-280U
R81 R82 R84 R85 R86	RES MF 10K 1/4W 2% RES MF 1K5 1/4W 2% RES MF 3K0 1/4W 2% RES MF 3K3 1/4W 2% RV CERM 500R LIN .5W 10% HORZ	24773-297M 24773-277U 24773-284J 24773-285F 25711-637F
R87 R89 R90 R91 R92	RES MF 150R 1/4W 2% RV CERM 50K LIN .5W 10% HORZ RES MF 22K 1/4W 2% RES MG 3M3 1/4W 5% RES MG 3M3 1/4W 5%	24773-253F 25711-643S 24773-305R 24321-879G 24321-879G
R93 R94 R95 R96 R97	RES MF 1KO 1/4W 2% RES MF 1OK 1/4W 2% RV CERM 1OK LIN .5W 10% HORZ RES MF 8K2 1/4W 2% RES MF 2K7 1/4W 2%	24773-273A 24773-297M 25711-641G 24773-295P 24773-283L
R98	RES MF 620R 1/4W 2%	24773-268B
SKAY	CONN ASSY SKAY	43129-679G
TR1 TR2 TR3 TR4 TR5	TRANS PNP SIL BC308 25V TRANS NPN SIL BFR91 12V TRANS PNP SIL BC308 25V TRANS NPN SIL BFR91 12V TRANS PNP SIL BC308 25V	28433-455R 28451-696U 28433-455R 28451-696U 28433-455R
TR6	TRANS NPN SIL ZTX109CL 20V	28452 -771 P
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Circuit Ref	Description	Part Number
Unit AC4	- OUTPUT AMPLIFIER	(Contd.)
TR7 TR8 TR9 TR10	TRANS PNP SIL BC308 25V TRANS NPN SIL BFR96 15V TRANS PNP SIL BC308 25V TRANS NPN SIL BFQ34 18V	28433-455R 28452-171Y 28433-455R 28452-247V
TR11 TR12 TR13 TR14 TR15	TRANS NPN SIL 2N2369 15V TRANS FET J310 25V TRANS NPN SIL 2N2369 15V TRANS FET J310 25V TRANS NPN SIL 2N2369 15V	28452-197H 28459-028E 28452-197H 28459-028E 28452-197H
TR16 TR17	TRANS PNP SIL BC308 25V TRANS NPN SIL ZTX109CL 20V	28433-455R 28452-771P
Unit AC5	- AMPLITUDE MODULATOR	Issue 4
20. Whe	n ordering, prefix circuit reference with	AC5
	Complete unit	44828-440B
C1 C2 C3 C4 C5	CAP CER .001UF 63V 10% PLATE CAP CER .039UF 50V 20% CHIP CAP CER 0.01UF 100V 20% DISC CAP CER .039UF 50V 20% CHIP CAP CER .001UF 63V 10% PLATE	26383-585M 26386-493F 26383-055L 26386-493F 26383-585M
C6 C7 C8 C9 C10	CAP CER 0.01UF 100V 20% DISC CAP CER .039UF 50V 20% CHIP CAP CER .039UF 50V 20% CHIP CAP CER .039UF 50V 20% CHIP CAP TANT 4.7UF 35V 20% BEAD	26383-055L 26386-493F 26386-493F 26386-493F 26486-219P
C11 C12 C13 C14 C15	CAP TANT 4.7UF 35V 20% BEAD CAP TANT 4.7UF 35V 20% BEAD CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC	26486-219P 26486-219P 26383-055L 26383-055L 26383-055L
C16	CAP CER 0.01UF 100V 20% DISC	26383-055L
IC1 IC2 IC3 IC4	MOD HYB OM345 VHF/UHF AMP SIL ICD FF D 7474 DUAL +EDG TR ICA AMP TLO71CP FET I/P DIL8 ICA DAC AD7524JN 8BIT	28461-351Z 28462-002N 28461-347A 28469-400R
PLDC	CON PART PCB POST SQUARE PIN	23435-188 v

Circuit Ref	Description	Part Number
Unit AC5	- AMPLITUDE MODULATOR	(Contd.)
PLDD	CON PART PCB POST SQUARE PIN	23435-188V
R1 R2 R3 R4 R5	RES CC 51R 1/8W 5% RES CC 270R 1/8W 5% RES CHIP 16R 5% RES CC 270R 1/8W 5% RES MF 330R 1/4W 2%	24331-989P 24331-992P 24681-043E 24331-992P 24773-261D
R6 R7 R8 R9 R10	RES CC 22R 1/8W 5% RES CC 51R 1/8W 5% RES MF 5K1 1/4W 2% RES MF 10K 1/4W 2% RES MF 240R 1/4W 2%	24331-988T 24331-989P 24773-290V 24773-297M 24773-258D
R11 R12 R13 R14 R15	RES MF 240R 1/4W 2% RES CHIP 16R 5% RES MF 3K6 1/4W 2% RES MF 510R 1/4W 2% RES MF 330R 1/4W 2%	24773-258D 24681-043E 24773-286G 24773-266C 24773-261D
R16 R17 R18 R20 R21	RES NET 10K 5% 8DIL DIL RES MF 10K 1/4W 2% RES MF 3K0 1/4W 2% RES MF 10K 1/4W 2% RES MF 18K 1/4W 2%	24681-511P 24773-297M 24773-284J 24773-297M 24773-303M
R22 R23	RES MF 18K 1/4W 2% RV CERM 500R LIN .5W 10% HORZ	24773-303M 25711-637F
SKDE SKDF	CON RF SMB MALE 50 PCB STR CON RF SMB MALE 50 PCB STR	23444-334Y 23444-334Y
TR1 TR2 TR3	TRANS NPN SIL BFR90 15V TRANS PNP SIL BC308 25V TRANS NPN SIL ZTX109CL 20V	28452-167U 28433-455R 28452-771P
X1 X2	MIXER SBL1 DOUBLE BAL DIODE MIXER TFM2 DOUBLE BAL	28531-002A 28531-003Z
Unit AC13	-FILTER & FREQ DOUBLER BOARD (2019 only)Issue 10
21. When	n ordering, prefix circuit reference with	AC13
	Complete unit	44828-437B
C1 C2 C3	CAP CER .039UF 50V 20% CHIP CAP CER 0.01UF 100V 20% DISC CAP CER .039UF 50V 20% CHIP	26386-493F 26383-055L 26386-493F

Circu Ref		ANAPOS AND STATE STA	Description	Part Number
Unit	AC13		FILTER & FREQ DOUBLER BOARD	(Contd.)
C4	CAP	CER	.039UF 50V 20% CHIP	26386-493F
C5	CAP	CER	.039UF 50V 20% CHIP	26386-493F
C6			.039UF 50V 20% CHIP	26386-493F
C7			.039UF 50V 20% CHIP	26386-493F
C8			.039UF 50V 20% CHIP	26386-493F
C9 C10			.039UF 50V 20% CHIP D.01UF 100V 20% DISC	26386-493F 26383-055L
010	CAF	UEM !	0.010f 1004 50% DISC	50302-0331
C11			0.047UF 25V 20% DISC	26383 - 017U
C12	CAP		0.01UF 100V 20% DISC	26383-055L
C13			0.01UF 100V 20% DISC	26383-055L
C14			0.01UF 100V 20% DISC	26383-055L
C15	CAP	CEH 1	0.01UF 100V 20% DISC	26383-055L
C16	CAP	CER	0.01UF 100V 20% DISC	26383-055L
C18	CAP	CER	0.01UF 100V 20% DISC	26383-055L
C19			0.01UF 100V 20% DISC	26383-055L
C20			3.2PF 63V .5PF PLATE	26343-464Z
C21	CAP	CER	12PF 63V 5% PLATE	26343-466E
C22	CAP	CER	3.2PF 63V .5PF PLATE	26343 – 464Z
C23	CAP	CER	.001UF 63V 10% PLATE	26383-585M
C24			.001UF 63V 10% PLATE	26383-585M
C25			.001UF 63V 10% PLATE	26383-585M
C26	CAP	CER	.001UF 63V 10% PLATE	26383-585M
C27	CAP	CER	.001UF 63V 10% PLATE	26383-585M
C28	CAP	CER (5.8PF 63V .5PF PLATE	26343-463A
C29		CER		26343-468Y
C30		CER 2		26343-469N
C31	CAP	CER	18PF 63V 5% PLATE	26343-468Y
C32	CAP	CEH 2		26343-469N
C33		CER :		26343-471Y
C34		CER :		26343-469N
C35		CER :		26343-471Y
C36	CAP	CER	A7PF 63V 5% PLATE	26343-473L
C37			33PF 63V 5% PLATE	26343-471Y
C38			17PF 63V 5% PLATE	26343-473L
C39			S8PF 63V 2% PLATE	26343-475F
C40			17PF 63V 5% PLATE	26343-473L
C41	CAP	CER	58PF 63V 2% PLATE	26343-475F
C42			100PF 63V 2% PLATE	26343-477V
C43			S8PF 63V 2% PLATE	26343-475F
C44			32PF 63V 2% PLATE	26343-476G
C45			150PF 63V 2% PLATE	26343-479W
C46	CAP	CER	32PF 63V 2% PLATE	26343-476G
C47	CAP	CER	001UF 63V 10% PLATE	26383-585M

Circuit Ref	Description	Part Number
Unit AC13	- FILTER & FREQ DOUBLER BOARD	(Contd.)
C48 C49 C50 C51	CAP CER .001UF 63V 10% PLATE CAP CER .001UF 63V 10% PLATE CAP CER .001UF 63V 10% PLATE CAP CER 12PF 63V 5% PLATE	26383-585M 26383-585M 26383-585M 26343-466E
C52 C53 C54 C55 C56	CAP CER 18PF 63V 5% PLATE CAP CER 12PF 63V 5% PLATE CAP CER .001UF 63V 10% PLATE CAP CER 1.8PF 63V .5PF PLATE CAP CER .001UF 63V 10% PLATE	26343-468Y 26343-466E 26383-585M 26343-456C 26383-585M
C57 C58 C59 C60 C61	CAP CER .001UF 63V 10% PLATE CAP CER .001UF 63V 10% PLATE CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC	26383-585M 26383-585M 26383-055L 26383-055L 26383-055L
C62 C63 C64 C65 C66	CAP CER 0.01UF 100V 20% DISC CAP CER 2.2PF 63V .5PF PLATE CAP CER 100PF 63V 2% PLATE CAP CER 120PF 63V 2% PLATE CAP CER 33PF 63V 5% PLATE	26383-055L 26343-457R 26343-477V 26343-478S 26343-471Y
C67 C68 C69 C70	CAP CER 100PF 63V 2% PLATE CAP CER 22PF 63V 5% PLATE CAP CER 150PF 63V 2% PLATE CAP CER 180PF 63V 2% PLATE CAP CER 150PF 63V 2% PLATE	26343-477V 26343-469N 26343-479W 26343-480V 26343-479W
C72 C73 C74 C75 C76	CAP CER 22PF 63V 5% PLATE CAP CER 180PF 63V 2% PLATE CAP CER 270PF 63V 2% PLATE CAP CER 180PF 63V 2% PLATE CAP CER 270PF 63V 2% PLATE	26343-469N 26343-480V 26343-482W 26343-480V 26343-482W
C77 C78 C79 C80 C81	CAP CER 390PF 63V 10% PLATE CAP CER 270PF 63V 2% PLATE CAP CER 470PF 63V 10% PLATE CAP CER 560PF 63V 10% PLATE CAP CER 470PF 63V 10% PLATE	26383-598Y 26343-482W 26383-582T 26383-581D 26383-582T
C82 C83 C84 C85 C86	CAP CER 560PF 63V 10% PLATE CAP CER 820PF 63V 10% PLATE CAP CER 47PF 63V 5% PLATE CAP CER 560PF 63V 10% PLATE CAP CER 0.01UF 100V 20% DISC	26383-581D 26383-584X 26343-473L 26383-581D 26383-055L
C87 C88 C89 C90	CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP CER 68PF 63V 2% PLATE CAP CER 82PF 63V 2% PLATE	26383-055L 26383-055L 26383-055L 26343-475F 26343-476G

Circuit	Description	Part Number
Unit AC13	- FILTER & FREQ DOUBLER BOARD	(Contd.)
C92 C93 C94 C95 C96	CAP CER 68PF 63V 2% PLATE CAP CER 33PF 63V 5% PLATE CAP CER 2.2PF 63V .5PF PLATE CAP CER 0.01UF 100V 20% DISC CAP CER 47PF 63V 5% PLATE	26343-475F 26343-471Y 26343-457R 26383-055L 26343-473L
C97 C98 C99 C100 C101	CAP CER 68PF 63V 2% PLATE CAP CER 47PF 63V 5% PLATE CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP CER .001UF 63V 10% PLATE	26343-475F 26343-473L 26383-055L 26383-055L 26383-585M
C102 C103 C104 C106 C107	CAP TANT 4.7UF 35V 20% BEAD CAP TANT 4.7UF 35V 20% BEAD CAP TANT 4.7UF 35V 20% BEAD CAP CER .039UF 50V 20% CHIP CAP CER .039UF 50V 20% CHIP	26486-219P 26486-219P 26486-219P 26386-493F 26386-493F
C108 C109 C110 C111 C112	CAP CER .039UF 50V 20% CHIP CAP CER .039UF 50V 20% CHIP CAP CER .039UF 50V 20% CHIP CAP CER .001UF 63V 10% PLATE CAP CER .039UF 50V 20% CHIP	26386-493F 26386-493F 26386-493F 26383-585M 26386-493F
C113 C114 C115 C116 C117	CAP CER 10PF 63V .5PF PLATE CAP CER .039UF 50V 20% CHIP CAP CER 2.2PF 63V .5PF PLATE CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC	26343-465H 26386-493F 26343-457R 26383-055L 26383-055L
C118 C119 C120 C121 C122	CAP CER 2.7PF 63V .5PF PLATE CAP CER 15PF 63V 5% PLATE CAP CER 8.2PF 63V .5PF PLATE CAP CER 1.0PF 63V .5P PLATE CAP CER .001UF 63V 10% PLATE	26343-458B 26343-467U 26343-464Z 26343-502Z 26383-585M
C123 C124 C125 C126 C127	CAP CER 10PF 63V .5PF PLATE CAP CER 5.6PF 63V .5PF PLATE CAP CER 1.0PF 63V .5P PLATE CAP CER .039UF 50V 20% CHIP CAP CER .039UF 50V 20% CHIP	26343-465H 26343-462K 26343-502Z 26386-493F 26386-493F
C128 C129 C130 C131 C132	CAP CER .001UF 63V 10% PLATE CAP CER .039UF 50V 20% CHIP CAP CER .001UF 63V 10% PLATE CAP CER .039UF 50V 20% CHIP CAP CER .001UF 63V 10% PLATE	26383-585M 26386-493F 26383-585M 26386-493F 26383-585M
C135 C136 C137	CAP CER 3.3PF 63V .5PF PLATE UNCL PRINTED CAP CAP CER 5.6PF 63V .5PF PLATE	26343-459K 26343-462K

Circuit	Description	Part Number
Unit AC13	- FILTER & FREQ DOUBLER BOARD	(Contd.)
C138 C139	CAP CER 2.7PF 63V .5PF PLATE CAP CER .001UF 63V 10% PLATE	26343-458B 26383-585M
C140 C141 C142 C143 C144	CAP CER 3.9PF 63V .5PF PLATE CAP CER 2.2PF 63V .5PF PLATE CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC	26343-460R 26343-457R 26383-055L 26383-055L 26383-055L
C145 C146 C147 C148 C149	CAP CER .001UF 63V 10% PLATE CAP CER 2.7PF 63V .5PF PLATE	26383-585M 26383-585M 26383-585M 26383-585M 26343-458B
C151 C152	CAP CER 4.7PF 63V .5PF PLATE CAP CER .001UF 63V 10% PLATE	26343-461B 26383-585M
D1 D2 D3 D4 D5	DIODE SIL BA482 35V JUNC DIODE SIL BA482 35V JUNC DIODE SIL 1N4148 100V JUNC DIODE SIL 1N4148 100V JUNC DIODE SIL BA482 35V JUNC	28335-675R 28335-675R 28336-676J 28336-676J 28335-675R
D6 D7 D8 D9 D10	DIODE SIL BA482 35V JUNC	28335-675R 28335-675R 28335-675R 28335-675R 28335-675R
D11 D12 D13 D14 D15	DIODE SIL BA482 35V JUNC	28335-675R 28335-675R 28335-675R 28335-675R 28335-675R
D16 D17 D18 D19 D20	DIODE SIL BA482 35V JUNC	28335-675R 28335-675R 28335-675R 28335-675R 28335-675R
D21 D22 D23 D24 D25	DIODE SIL BA482 35V JUNC	28335-675R 28335-675R 28335-675R 28335-675R 28335-675R
D26 D27 D28 D29	DIODE SIL BA482 35V JUNC	28335-675R 28335-675R 28335-675R 28335-675R

Circuit Ref			Description					Part Number	
Unit	AC13		- F	ILTER	& FR	EQ DOUBLER	BOARD	(Co	ontd.)
D30		DIODE	SIL	BA482	35 V	JUNC		283	35-675R
D31		DIODE	SIL	BA482	35V	JUNC		283	35-675R
D32		DIODE	SIL	BA482	35 V			283	35-675R
D33				BA482		JUNC		283	35-675R
D34				BA482		JUNC			35-675R
D35		DIODE	SIL	BA482	35V	JUNC		283	35-675R
D36				BA482	35V				35-675R
D37				BA482	_	JUNC			35-675R
D38				BA482	_	JUNC			35-675R
D39				BA482		JUNC			35-675R
D40		DIODE	SIL	BA482	35V	JUNC		283	35-675R
D41				BA482		JUNC		_	35-675R
D42				BA482		JUNC			35-675R
D43		DIODE		BA482 BA482	_	JUNC JUNC		_	35-675R 35-675R
D45				BA482		JUNC			35-675R
D46		DIODE	SIL	BA482	2511	JUNC		282	35-675R
D47		DIODE	SIL	BA482	35V				35-675R
D49		DIODE		BA482		JUNC		_	35-675R
D50		DIODE			-	JUNC		_	35-675R
D51				BA482	_	JUNC			35-675R
D52		DIODE	SIL	BA482	35V	JUNC		283	35-675R
D53		DIODE	SIL	BA482	35V	JUNC			35-675R
D54		DIODE	SIL	1N4148	8 10	OV JUNC		283	36-676J
D55				2-2080					
D56					Set	of three		445	29-058G
D57		DIODE	508	2-2080					
D58						OV JUNC			36-676J
D59				BA482	_				35-675R
D60 D61				BA482 BA482	_				35-675R 35-675R
וסע		DIODE	DIL	DA402	32V	JUNC		203	33-013V
D62				BA482				_	35-675R
D63						OV JUNC			36-676J
D64				BA482					35-675R
D65				BA482	_				35-675R
D66		DIODE	SIL	BA482	35 V	JUNC		203	35-675R
D67				BA482					35-675R
D68				BA482					35-675R
D69				BA482					35-675R 35-675R
D70 D71				BA482 BA482					35-675R
ויוע		DIONE	SIL	DH402	221	JUNC			
D72				BA482					35-675R
D73		DIODE	SIL	BA482	35V	JUNC		283	35-675R

Circuit Ref	Description	Part Number
Unit AC13	- FILTER & FREQ DOUBLER BOARD	(Contd.)
D74 D75	DIODE HOT CARR 1N5390 DIODE HOT CARR 1N5390	28349-005Z 28349-005Z
IC1 IC2 IC3 IC4 IC5	ICD DEC/DMX 74LS138 3-8 ICD FF D 74LS273 OCT +EDG TR ICD FF D 74LS273 OCT +EDG TR ICD BUFF 7407 HEX O/C ICD INV 7405A HEX O/C	28465-027F 28462-615U 28462-615U 28469-703X 28469-157K
IC6 IC7 IC8	ICD FF D 74LS175 QUAD +EDG TR ICD BUFF 7407 HEX O/C ICA AMP UA741CN GP DIL8	28462-614E 28469-703X 28461-304T
L1 L2 L3 L4 L5	IND CHOKE 68UH 10% IND CHOKE 4.7UH 10% IND CHOKE 68UH 10% 6-HOLE FERRITE, 2.4UH INDUCTOR 6-HOLE FERRITE, 2.4UH INDUCTOR	23642-560S 23642-553J 23642-560S 44290-790U 44290-790U
L6 L7 L8 L9	PRINTED COIL PRINTED COIL IND CHOKE 4.7UH 10% IND CHOKE 4.7UH 10% IND CHOKE 4.7UH 10%	23642-553J 23642-553J 23642-553J
L11 L12 L13 L14 L15	IND CHOKE 4.7UH 10% IND CHOKE 4.7UH 10% ADJ. IND. 30NH 1 3/4 T ADJ. IND. 30NH 1 3/4 T ADJ. IND. 43NH 2 1/4 T	23642-553J 23642-553J 44290-799W 44290-799W 44290-800J
L16 L17 L18 L19 L20	ADJ. IND. 43NH 2 1/4 T ADJ. IND. 61NH 2 3/4 T ADJ. IND. 61NH 2 3/4 T ADJ. IND. 86NH 3 3/4 T ADJ. IND. 86NH 3 3/4 T	44290-800J 44290-801F 44290-801F 44290-802G 44290-802G
L21 L22 L23 L24 L25	ADJ. IND. 121NH 4 3/4 T ADJ. IND. 121NH 4 3/4 T ADJ. IND. 172NH 6 3/4 T ADJ. IND. 172NH 6 3/4 T IND CHOKE 4.7UH 10%	44290-803V 44290-803V 44290-804S 44290-804S 23642-553J
L26 L27 L28 L30 L31	IND CHOKE 4.7UH 10% IND CHOKE 4.7UH 10% IND CHOKE 4.7UH 10% PRINTED COIL PRINTED COIL	23642-553J 23642-553J 23642-553J
L33 L34 L36	IND CHOKE 4.7UH 10% IND CHOKE 4.7UH 10% IND CHOKE 4.7UH 10%	23642-553J 23642-553J 23642-553J

Circuit Ref	Description	Part Number
Unit AC13	- FILTER & FREQ DOUBLER BOARD	(Contd.)
L37	IND CHOKE 68UH 10%	23642 - 560S
L38	IND CHOKE 68UH 10%	23642-560S
L39	IND CHOKE 68UH 10%	23642-560S
L40	IND CHOKE 68UH 10%	23642-5608
L41	IND CHOKE 1.8UH 5%	23642-495X
L42	IND CHOKE 1.8UH 5%	23642-495X
L43	IND CHOKE 3.0UH 5%	23642-474Н
L44	IND CHOKE 3.0UH 5%	23642-474Н
L45	IND CHOKE 4.3UH 5%	23642-466R
L46	IND CHOKE 4.3UH 5%	23642-466R
L47	IND CHOKE 6.2UH 5%	23642-4558
L48	IND CHOKE 6.2UH 5%	23642-4558
L49	IND CHOKE 8.2UH 5%	23642-468K
L50	IND CHOKE 8.2UH 5%	23642-468K
L51	IND CHOKE 12UH 5%	23642-456W
L52	IND CHOKE 12UH 5%	23642-456W
L53	IND CHOKE 68UH 10%	23642 – 560S
L54	IND CHOKE 68UH 10%	23642-5608
L55	IND CHOKE 68UH 10%	23642-5608
L56	IND CHOKE 68UH 10%	23642-5608
L57	IND CHOKE 68UH 10%	23642-5608
L58	IND CHOKE 1.5UH 5%	23642-494P
L59	IND CHOKE 1.5UH 5%	23642-494P
L60	IND CHOKE 68UH 10%	23642-560S
L61	IND CHOKE 68UH 10%	23642-560\$
L62	IND CHOKE 68UH 10%	23642-5608
L63	IND CHOKE 0.82UH 5%	23642-454B
L64	IND CHOKE 0.82UH 5%	23642-454B
L65	IND CHOKE 68UH 10%	23642-5608
L66	IND CHOKE 68UH 10%	23642-560S
L67 L68	PRINTED COIL PRINTED COIL	
FOO	PRINTED COIL	
L69	PRINTED COIL	
L70	RES. LEAD LENGTH	
L72	PRINTED COLL	
L73 L74	PRINTED COIL RF COIL 10UH 4T	44290-805W
		lillione Com-
L75	RF COIL 10UH 4T RF COIL 10UH 4T	44290-805W
L76 L77	RES. LEAD LENGTH	4429U-0UDW
L79	PRINTED COIL	
L80	PRINTED COIL	
L83	PRINTED COIL	

Circuit Ref	Description	Part Number
Unit AC13	- FILTER & FREQ DOUBLER BOARD	(Contd.)
L84 L90 L91 L92	PRINTED COIL 6-HOLE FERRITE, 2.4UH INDUCTOR RES. LEAD LENGTH RES. LEAD LENGTH	44290 – 7900
PLCM PLCN PLCP PLCR PLCT	CON PART PCB POST SQUARE PIN	23435-188V 23435-188V 23435-188V 23435-188V 23435-188V
PLDF	CONN ASSY	43129-537Y
R1 R2 R3 R4 R5	RES MF 360R 1/4W 2% RES MF 1KO 1/4W 2% RES MF 470R 1/4W 2% RES MF 3KO 1/4W 2% RES MF 3KO 1/4W 2%	24773-262T 24773-273A 24773-265M 24773-284J 24773-284J
R6 R7 R8 R9 R10	RES MF 75R 1/4W 2% RES MF 1K5 1/4W 2% RES CC 150R 1/8W 5% RES CC 150R 1/8W 5% RES CHIP 16R 5%	24773-246Y 24773-277U 24331-990D 24331-990D 24681-043E
R11 R12 R13 R14 R15	RES CHIP 16R 5% RES MF 51R 1/4W 2% RES MF 51R 1/4W 2% RES MF 6K8 1/4W 2% RES MF 6K8 1/4W 2%	24681-043E 24773-242Z 24773-242Z 24773-293D 24773-293D
R16 R17 R18 R19 R20	RES MF 200R 1/4W 2% RES MF 820R 1/4W 2% RES MF 75R 1/4W 2% RES MF 2K4 1/4W 2% RES MF 820R 1/4W 2%	24773-256S 24773-271B 24773-246Y 24773-282N 24773-271B
R22 R23 R24	RES MF 820R 1/4W 2% RES MF 3K9 1/4W 2% RES MF 360R 1/4W 2% RES MF 470R 1/4W 2% RES MF 5K6 1/4W 2%	24773-271B 24773-287V 24773-262T 24773-265M 24773-291S
R27 R28 R29	RES MF 300R 1/4W 2% RES MF 300R 1/4W 2% RES MF 6K8 1/4W 2% RES MF 270R 1/4W 2% RES MF 240R 1/4W 2%	24773-260W 24773-260W 24773-293D 24773-259T 24773-258D
R32	RES MF 10K 1/4W 2% RES MF 240R 1/4W 2% RES MF 1K0 1/4W 2%	24773-297M 24773-258D 24773-273A

Circuit Ref			
Unit AC13	- FILTER & FREQ DOUBLER BOARD	(Contd.)	
R34	RES MF 470R 1/4W 2%	24773-265M	
R35	RES MF 1K5 1/4W 2%	24773-2770	
R36	RES MF 470R 1/4W 2%	24773-265M	
R37	RES MF 1KO 1/4W 2%	24773-273A	
R38	RES MF 470R 1/4W 2%	24773-265M	
R39	RES MF 1KO 1/4W 2%	24773-273A	
R40	RES MF 470R 1/4W 2%	24773-265M	
R41	RES MF 240R 1/4W 2%	24773-258D	
R42	RES MF 470R 1/4W 2%	24773-265M	
R43	RES MF 680R 1/4W 2%	24773-269K	
R44	RES MF 680R 1/4W 2%	24773-269K	
R45	RES MF 680R 1/4W 2%	24773-269K	
R46	RES MF 680R 1/4W 2%	24773-269K	
R47	RES MF 1KO 1/4W 2%	24773-273A	
R48	RES MF 470R 1/4W 2%	24773-265M	
R50	RES MF 470R 1/4W 2%	24773-265M	
R51	RES MF 1KO 1/4W 2%	24773-273A	
R52	RES MF 470R 1/4W 2%	24773-265M	
R53	RES MF 1KO 1/4W 2%	24773-273A	
R54	RES MF 1K5 1/4W 2%	24773-2770	
R55	RES MF 470R 1/4W 2%	24773-265M	
R56	RES MF 470R 1/4W 2%	24773-265M	
R57	RES MF 470R 1/4W 2%	24773-265M	
R58	RES MF 10K 1/4W 2%	24773-297M	
R59	RES MF 10K 1/4W 2%	24773-297M	
R60	RES MF 10K 1/4W 2%	24773-297M	
R61	RES MF 10K 1/4W 2%	24773-297M	
R62	RES MF 2K7 1/4W 2%	24773-283L	
R63	RES MF 680R 1/4W 2%	24773-269K	
R64	RES CHIP 51R 5%	24681-045Y	
R65	RES CHIP 51R 5%	24681-045Y	
R66	RES MF 18R 1/4W 2%	24773-231P	
R67	RES MF 470R 1/4W 2%	24773-265M	
R68	RES MF 1KO 1/4W 2%	24773-273A	
R69	RES CC 51R 1/8W 5%	24331-989P	
R70	RES MF 3K9 1/4W 2%	24773-287V	
R71	RES MF 680R 1/4W 2%	24773-269K	
R72	RES CHIP 16R 5%	24681-043E	
R73	RES CC 100R 1/8W 5%	24331-997B	
R74	RES CHIP 10R 5%	24681-042H	
R75	RES CC 100R 1/8W 5%	24331-997B	
R76	RES MF 2K4 1/4W 2%	24773-282N	
R77	RES MF 2K4 1/4W 2%	24773-282N	

Circuit Ref	Description	Part Number
Unit AC13	- FILTER & FREQ DOUBLER BOARD	(Contd.)
R78 R79 R80 R81	RES MF 2K4 1/4W 2% RES MF 2K4 1/4W 2% RES MF 47K 1/4W 2% RES MF 36R 1/4W 2%	24773-282N 24773-282N 24773-313H 24773-238A
R82 R83 R84 R85 R86	RES MF 2K4 1/4W 2% RES MF 2K4 1/4W 2% RES CC 82R 1/8W 5% RES MF 3K9 1/4W 2% RES MF 680R 1/4W 2%	24773-282N 24773-282N 24331-996R 24773-287V 24773-269K
R87 R88 R89 R90 R91	RES CHIP 16R 5% RES CC 68R 1/8W 5% RES MF 240R 1/4W 2% RES CC 150R 1/8W 5% RES MF 470R 1/4W 2%	24681-043E 24331-979F 24773-258D 24331-990D 24773-265M
R92 R93 R99 R100 R101	RES MF 1K0 1/4W 2% RES MF 470R 1/4W 2% RES MF 3K9 1/4W 2% RES MF 3K9 1/4W 2% RES MF 3K9 1/4W 2%	24773-273A 24773-265M 24773-287V 24773-287V 24773-287V
R102 R103 R104 R105 R106	RES MF 3K9 1/4W 2% RES MF 3K9 1/4W 2% RES MF 1K0 1/4W 2% RES MF 47OR 1/4W 2% RES MF 3K9 1/4W 2%	24773-287V 24773-287V 24773-273A 24773-265M 24773-287V
R107 R108 R109 R110 R111	RES MF 3K9 1/4W 2% RES MF 47OR 1/4W 2% RES MF 47OR 1/4W 2% RES CHIP 1OR 5% RES CC 10OR 1/8W 5%	24773-287V 24773-265M 24773-265M 24681-042H 24331-997B
R112	RES CC 100R 1/8W 5%	24331-997B
SKCS	CON RF SMB MALE 50 PCB STR	23444-334Y
TR1 TR2 TR3 TR4 TR5	TRANS NPN SIL BFR96 15V TRANS NPN SIL BFR96 15V TRANS NPN SIL 2N2369 15V TRANS NPN SIL BFR96 15V TRANS NPN SIL BFR90 15V	28452-171Y 28452-171Y 28452-197H 28452-171Y 28452-167U
TR6	TRANS NPN SIL BFR91 12V	28451-696U

Circuit Ref	Description	Part Number
Unit AD1	- DISPLAY BOARD	Issue 2
22. When	ordering, prefix circuit reference	with AD1
	Complete unit	44828-441K
C1 C2 C3 C4	CAP TANT 4.7UF 35V 20% BEAD CAP TANT 4.7UF 35V 20% BEAD CAP PETP 0.022UF 250V 10% CAP TANT 4.7UF 35V 20% BEAD	26486-219P 26486-219P 26582-204X 26486-219P
D1	DIODE ZENER BZY88C10 10V 5%	28371-843E
IC1 IC2 IC3 IC4 IC5	ICD BUFF 7407 HEX O/C ICD BUFF 7407 HEX O/C ICD DRIV 4054 LCD ICD DECOD 4056 BCD-7SEG LCD ICD DECOD 4056 BCD-7SEG LCD	28469-401B
IC6 IC7 IC8 IC9 IC10	ICD DECOD 4056 BCD-7SEG LCD	28469-401B 28469-401B 28469-401B
IC11 IC12 IC13 IC14 IC15	ICD DECOD 4056 BCD-7SEG LCD ICD DRIV 4054 LCD ICD NOR 74LS02 QUAD 2INP ICD DRIV 4054 LCD ICD DECOD 4028 BCD-DEC	28469-398Z 28466-214Y 28469-398Z
IC16 IC17 IC18 IC19 IC20	ICD DECOD 4028 BCD-DEC ICD DECOD 4028 BCD-DEC ICD DRIV 4054 LCD ICD MONO 4047 ASTABLE MULTI ICD DRIV 4054 LCD	28465-013B
IC21 IC22 IC23 IC24 IC25	ICD DECOD 4056 BCD-7SEG LCD ICD DECOD 4056 BCD-7SEG LCD ICD DECOD 4056 BCD-7SEG LCD ICD DRIV 4054 LCD ICD DEC/DMX 4555 DUAL 2-4	28469-401B 28469-401B 28469-398Z
IC26 IC27 IC28 IC29	ICD DRIV 4054 LCD ICD DRIV 4054 LCD ICD DRIV 4054 LCD ICD DECOD 4056 BCD-7SEG LCD	28469-398Z 28469-398Z 28469-398Z 28469-401B

Circuit Ref	Description	Part Number
Unit AD1	- DISPLAY BOARD	(Contd.)
IC30	ICD DECOD 4056 BCD-7SEG LCD !	28469-401B
IC31 IC32 IC33	ICD DECOD 4056 BCD-7SEG LCD ! ICD DRIV 4054 LCD ! ICD DRIV 4054 LCD !	28469-401B 28469-398Z 28469-398Z
PLAL	CON PART PCB POST SQUARE PIN	23435-188V
R1 R2	RES NET 6K8 5% 15DIL RES MF 220K 1/4W 2%	24681-514C 24773-329T
X1 X2 X3	LCD 4575-363-060 LCD 4576-363-060 LCD 4577-363-060	44990-361M 44990-362C 44990-363R
Unit AD2	- MOTHER BOARD	Issue 1
23. When	ordering, prefix circuit reference with A	D2
	Complete unit	44828-442A
C1 C2	CAP CER 0.01UF 100V 20% DISC CAP CER 0.01UF 100V 20% DISC	26383-055L 26383-055L
IC1 IC2 IC3	ICD FF D 74LS273 OCT +EDG TR ICD BUFF 7406 HEX O/C I ICD NOR 74128 QUAD 2INP BUF	28462-615U 28469-158A 28466-224S
PLL PLW PLX PLY PLZ	CON PART PCB POST SQUARE PIN	23435-188V 23435-188V 23435-188V 23435-188V 23435-188V
PLAA PLAB PLAD PLAE PLAF	CON PART PCB POST SQUARE PIN	23435-188V 23435-188V 23435-188V 23435-188V 23435-188V
PLDM	CON PART PCB POST SQUARE PIN	23435-188V
SKAH	CON EDGE FEM 13 FXD .15 2S	23435-145E

	Circuit Ref Description					Part Number		
Unit	AD3	- MOD. OS	C. AND	FM CONTRO	L BOARD	1	[ssue	7
24.	When or	dering, pre	fix cir	cuit refe	rence wi	ith AI)3	
	Con	nplete unit				1	14828-	443Z
C1 C2 C3 C4 C5	CAF CAF	P CER 0.01UF (P PS 0.01UF (P PETP 0.68U) P PETP 0.15U)	63V 1% 63V 1% F 100V	10%		2	26383- 26515- 26515- 26582- 26582-	002C 002C 216E
C6 C7 C8 C9 C10	CAF CAF	CER 0.01UF CER 0.01UF CER 0.01UF CER 0.01UF	100V 2 100V 2 100V 2	20% DISC 20% DISC 20% DISC		6	26383 26383 26383 26383	055L 055L 055L
C11 C12 C13 C15 C16	CAP CAP CAP	CER 0.01UF CER 0.01UF CER 56PF 6 CER 0.01UF CER 0.01UF	100V 2 3V 2% F 100V 2	20% DISC PLATE 20% DISC		2	26383- 26383- 26343- 26383- 26383-	055L 474J 055L
C17 C18 C19 C20 C21	CAP CAP CAP	CER 0.01UF CER 0.01UF CER 0.01UF CER 0.01UF TANT .47UF	100V 2 100V 2 100V 2	20% DISC 20% DISC 20% DISC		6	26383- 26383- 26383- 26383- 26486-	055L 055L 055L
C23		TANT .47UF					26486- 26486-	
D1 D2 D3 D4 D5	DIC DIC	DDE SIL 1N41 DDE SIL 1N41 DDE SIL 1N41 DDE ZENER BZ DDE SIL 1N41	48 100v 48 100v 488C7v5	JUNC JUNC 7-5V 5%		6	28336- 28336- 28336- 28371- 28336-	676J 676J 603H
IC1 IC2 IC3 IC4 IC5	ICA ICA ICA	AMP TL072CI MUX 4053 TI MUX 4052 DI MUX 4053 TI FF D 74LS2	RIP 3IN UAL 4IN RIP 3IN	IP IP IP	grad man grad	4	28461- 28469- 28469- 28469- 28462-	714H 713Z 714H
IC6	ICA	MUX 4053 TI	RIP 3IN	IP	•	é	28469-	714H

Circuit Ref	Description	Part Number
Unit AD3	- MOD. OSC. AND FM CONTROL BOARD	(Contd.)
IC7 IC8 IC9 IC10	ICA MUX 4053 TRIP 3INP ICA AMP TL072CP DUAL FET I/P ICA AMP TL072CP DUAL FET I/P ICA AMP TL072CP DUAL FET I/P	28469-714H 28461-348Z 28461-348Z 28461-348Z
IC11 IC12 IC13 IC14 IC15	ICA DAC AD7524JN 8BIT ICA AMP TL071CP FET I/P DIL8 ICD INV 74LS04 HEX ICD DEC/DMX 74LS138 3-8 ICA DAC AD7522LN 10BIT MOS	28469-400R 28461-347A 28469-171L 28465-027F 28469-402K
IC16 IC17 IC18 IC19	ICA AMP TL071CP FET I/P DIL8 ICA DAC AD7524JN 8BIT ICA AMP TL071CP FET I/P DIL8 ICA AMP NE5534AH H-PRF T099	28461-347A 28469-400R 28461-347A 28461-329V
R1 R2 R3 R4 R5	RES MF 130R 1/4W 2% RV THERM 10K 20% GLASS RA14 RES MF 2K56 1/4W 0.5% 25PPM RES MF 5K05 1/4W 0.5% 50PPM RES MF 15K83 1/4W 0.5%	24773-252J 25683-389E 24753-564F 24753-667G 24753-560Y
R6 R7 R8 R9 R10	RES MF 39K7 1/4W 0.5% RES MF 53K0 1/4W 0.5% RES MF 5K05 1/4W 0.5% 50PPM RES MF 15K83 1/4W 0.5% RES MF 39K7 1/4W 0.5%	24753-561N 24753-562L 24753-667G 24753-560Y 24753-561N
R11 R12 R13 R14 R15	RES MF 53K0 1/4W 0.5% RES MF 2K56 1/4W 0.5% 25PPM RES MF 100K 1/4W 2% RES MF 470R 1/4W 2% RES MF 4K7 1/4W 2%	24753-562L 24753-564F 24773-321L 24773-265M 24773-289W
R16 R17 R18 R19 R20	RV CERM 2K LIN .3W 10% FLAT RES MF 10K 1/4W 2% RES MF 390R 1/4W 2% RES MF 620R 1/4W 2% RES MF 100R 1/4W 2%	25748-505T 24773-297M 24773-263P 24773-268B 24773-249J
R21 R22 R23 R24 R25	RES MF 1MO 1/4W 2% RES MF 1MO 1/4W 2% RES MF 12K 1/4W 2% RES MF 3KO 1/4W 2% RES MF 270K 1/4W 2%	24773-346E 24773-346E 24773-299R 24773-284J 24773-331D
R26 R27 R28 R29 R30 R31	RES MF 270K 1/4W 2% RES MF 5K6 1/4W 2% RES MF 1K0 1/4W 2% RES MF 1K0 1/4W 2% RV CERM 500R LIN .3W 10% FLAT RES MF 6K8 1/4W 2%	24773-331D 24773-291S 24773-273A 24773-273A 25748-503W 24773-293D

Circuit Ref	Description	Part Number
Unit AD3	- MOD. OSC. AND FM CONTROL BOARD	(Contd.)
R32 R33 R34 R35	RES MF 12K 1/4W 2% RV CERM 500R LIN .3W 10% FLAT RES MF 1KO 1/4W 2% RES NET 10K 5% 8DIL DIL	24773-299R 25748-503W 24773-273A 24681-511P
R36 R37 R38 R39 R40	RES MF 390R 1/4W 2% RES MF 10K 1/4W 2% RES MF 240R 1/4W 2% RES MF 39K 1/4W 2% RES MF 470R 1/4W 2%	24773-263P 24773-297M 24773-258D 24773-311A 24773-265M
R41 R42 R43 R44 R45	RES MF 240R 1/4W 2% RES MF 10K 1/4W 2%	24773-258D 24773-297M 24773-297M 24773-297M 24773-297M
R46 R47 R48 R49	RES MF 10K 1/4W 2% RES MF 10K 1/4W 2% RES MF 10K 1/4W 2% RES MF 10K 1/4W 2%	24773-297M 24773-297M 24773-297M 24773-297M
TR1	TRANS FET J310 25V	28459-028E
Unit AD4	- KEYBOARD	Issue 3
25. Whe	on ordering, prefix circuit reference with Complete unit	AD4 44828-444Н
C1 C2 C3 C4 C5	CAP CER 0.01UF 40V 20%+ PLATE	26387-253M 26387-253M 26387-253M 26387-253M 26387-253M
D1 D2 D3 D4 D5	DIODE LED LLL37 2.4V YELLOW	28624-106T 28624-106T 28624-106T 28624-106T 28624-106T
D8 D10 D11 D12 D13	DIODE LED CQY87V180P 2.4V YEL	28624-121Z 28624-121Z 28624-121Z 28624-121Z 28624-121Z

Circuit Ref	Description	Part Number
Unit AD4	- KEYBOARD	(Contd.)
D14 D15	DIODE LED CQY87V180P 2.4V YEL DIODE LED CQY87V180P 2.4V YEL	28624 -121Z 28624 -121Z
IC1 IC2 IC3 IC4 IC5	ICD DEC/DMX 74LS138 3-8 ICD FF D 74LS273 OCT +EDG TR ICD FF D 74LS273 OCT +EDG TR ICD FF D 74LS273 OCT +EDG TR ICD BUFF 74LS244 OCT 3ST	28465-027F 28462-615U 28462-615U 28462-615U 28469-182T
R1 R2 R3 R4 R5	RES MF 330R 1/4W 2% RES NET 100R 5% 8SINGLE DIL RES MF 100K 1/4W 2% RES MF 100K 1/4W 2% RES NET 10K 5% 8DIL DIL	24773-261D 24681-515R 24773-321L 24773-321L 24681-511P
SA SB SC SD SE	SW PUSH BUTTON SPCO 24V 10MA	23465-411B 23465-411B 23465-411B 23465-411B 23465-411B
SF SH SJ SK SL	SW PUSH BUTTON SPCO 24V 10MA	23465-411B 23465-411B 23465-411B 23465-411B 23465-411B
SM SP SR SS ST	SW PUSH BUTTON SPCO 24V 10MA	23465-411B 23465-411B 23465-411B 23465-411B 23465-411B
SU SV SW SX SY	SW PUSH BUTTON SPCO 24V 10MA	23465-411B 23465-411B 23465-411B 23465-411B 23465-411B
SZ SAA SAB SAC SAD	SW PUSH BUTTON SPCO 24V 10MA	23465-411B 23465-411B 23465-411B 23465-411B 23465-411B
SAE SAF SAH SAJ	SW PUSH BUTTON SPCO 24V 10MA SW PUSH BUTTON SPCO 24V 10MA SW PUSH BUTTON SPCO 24V 10MA SW PUSH BUTTON SPCO 24V 10MA	23465-411B 23465-411B 23465-411B 23465-411B

Circuit Ref	Description	Part Number
Unit AD4	- KEYBOARD	(Contd.)
SAK	SW PUSH BUTTON SPCO 24V 10MA	23465-411B
SAL SAM	SW PUSH BUTTON SPCO 24V 10MA SW PUSH BUTTON SPCO 24V 10MA	23465-411B 23465-411B
TR1 TR2	TRANS NPN SIL ZTX109CL 20V TRANS NPN SIL ZTX109CL 20V	28452-771P 28452-771P
Unit AE1	- POWER SUPPLY BOARD	Issue 4
26. Whe	on ordering, prefix circuit reference with	AE1
	Complete unit	44828-446U
C1 C2 C3 C4 C5	CAP ELEC 15000UF 16V -10+30% CAP ELEC 22UF 25V 20%+	26422-3208 26415-805K 26415-805K 26415-805K 26415-805K
C6 C7 C8 C9 C10	CAP ELEC 4700UF 40V -10+30% CAP ELEC 2200UF 40V 20%+ CAP ELEC 22UF 25V 20%+ CAP ELEC 4.7UF 63V 20%+ CAP ELEC 220UF 63V 20%+	26422-321W 26415-831P 26415-805K 26415-801M 26415-820J
C11 C12	CAP ELEC 22UF 25V 20%+ CAP ELEC 4.7UF 63V 20%+	26415-805K 26415-801M
D1 D2 D3 D4 D5	DIODE BRIDGE 2KBB2OR 200V 1.9A DIODE BRIDGE 2KBB2OR 200V 1.9A DIODE BRIDGE 2KBB2OR 200V 1.9A DIODE RECT 1N4004 400V DIODE RECT 1N4004 400V	28359-189D 28359-189D 28359-189D 28357-028K 28357-028K
D6 D7 D8	DIODE RECT 1N4004 400V DIODE RECT 1N4004 400V DIODE RECT 1N4004 400V	28357-028K 28357-028K 28357-028K
IC1 IC2	ICA VREG- LM337T PROG 1A5 ICA VREG+ LM317T PROG 1A5	28461-727Z 28461-726A
PLB PLC PLD PLE PLH	CON PART PCB POST SQUARE PIN	23435-188V 23435-188V 23435-188V 23435-188V 23435-188V
PLJ PLK	CON PART PCB POST SQUARE PIN CON PART PCB POST SQUARE PIN	23435-188V 23435-188V

Circuit Ref	Description	Part Number
Unit AE1	- POWER SUPPLY BOARD	(Contd.)
R1 R2 R3 R4 R5	RES MF 220R 1/4W 2% RV CERM 50R LIN .5W 10% HORZ RES MF 680R 1/4W 2% RES MF 220R 1/4W 2% RV CERM 50R LIN .5W 10% HORZ	24773-257W 25711-634N 24773-269K 24773-257W 25711-634N
R6 R7 R8 R9 R10	RES MF 2K7 1/4W 2% RES MF 22OR 1/4W 2% RV CERM 5OR LIN .5W 10% HORZ RES MF 2K7 1/4W 2% RES MF 22OR 1/4W 2%	24773-283L 24773-257W 25711-634N 24773-283L 24773-257W
R11 R12	RV CERM 50R LIN .5W 10% HORZ RES MF 4K3 1/4W 2%	25711-634N 24773-288S
Unit AMO	- BASIC MODULE (44990-380J)	Issue 7
27. When	ordering, prefix circuit reference with AM	10
D1	DIODE BRIDGE BY260 200V 12A	28359 - 190S
FS1 FS2 FS3 FS4	FUSE T/LAG .50A 20X5MM FUSE T/LAG .50A 20X5MM FUSE T/LAG 1.0A 20X5MM FUSE T/LAG 1.0A 20X5MM	23411-056X 23411-056X 23411-058C 23411-058C
IC1 IC2	ICA VREG+ LM350K PROG 3A TO3 ICA VREG+ LM317K PROG 1A5 TO3	28461-722C 28461-728H

Circuit Ref	Description	Part Number	
Unit AMO	- BASIC MODULE	(Contd.)	
PLAU PLAU PLAV PLAY PLBA	CON PWR MALE 3 FXD RF FILTER CONN ASSY PLAU-PLAW CONN ASSY PLAY-PLAX CONN ASSY PLAY-PLAZ CONN ASSY PLBA-SKBB	23423-150L 43129-655T 43129-656P 43129-657X 43129-658M	
SAP SAR SAS	SW TOG 2P2W LEVER MAINS SW SLIDE DPCO PANEL MTG SW SLIDE DPCO PANEL MTG	23462-249Z 23467-161W 23467-161W	
SKB SKC SKE SKH SKJ	CONN ASSY SKB CONN ASSY SKC CONN ASSY SKE-SKM CONN ASSY SKH-SKW CONN ASSY SKJ	43129-694C 43129-695R 43129-643M 43129-645J 43129-646F	
SKK SKL SKV SKX SKY	CONN ASSY SKK CONN ASSY SKL CONN ASSY SKV-SKAE CONN ASSY SKX CONN ASSY SKY-SKAK	43129-647G 43129-651V 43129-649S 43129-650G 43129-691P	
SKZ SKAA SKAB SKAF SKAN	CONN ASSY SKZ CONN ASSY SKAA CONN ASSY SKAB-SKAL CONN ASSY SKAF CON RF BNC FEM 50 BKHD	43129-644L 43129-652S 43129-653W 43129-648V 23443-446H	
SKAP	CONN ASS SKAP-PLAR	43129-654D	
T1	MAINS TRANSFORMER	43490-074Z	
R1 R2 R3 R4 R5	RES MF 220R 1/4W 2% RV CERM 50R LIN .5W 10% HORZ RES MF 680R 1/4W 2% RES MF 220R 1/4W 2% RV CERM 50R LIN .5W 10% HORZ	24773-257W 25711-634N 24773-269K 24773-257W 25711-634N	
X1 X2 X3 X4	FUSE HOLDER PANEL MOUNTED COVER FOR FUSE HOLDER COVER MAINS FILTER COVER (MAINS SW)	23416-192R 23416-198E 37590-150P 37590-298U	

Circuit Ref	Description	Part Number	
Unit ATO	- 10DB STEP ATTENUATOR ASSEMBLY	Issue 3	
28. When	ordering, prefix circuit reference with A	ro	
	Complete unit	44990-353W	
C1 C2 C3	CAP CER .001UF 500V 20%+ L/T CAP CER .001UF 500V 20%+ L/T CAP CER .001UF 500V 20%+ L/T	26373-714F 26373-714F 26373-714F	
RLA RLB RLC RLD RLE	SOLENOID ASSY SOLENOID ASSY SOLENOID ASSY SOLENOID ASSY SOLENOID ASSY	44990-370Z 44990-370Z 44990-370Z 44990-370Z 44990-370Z	
SKN SKP SKAZ SKBA	CONN ASSY SKN CONN ASSY SKP CON RF SMC MALE 50 BKHD SOLDER CON RF SMA FEM 50 PANEL SOLDER	43129-689X 43129-690T 23444-382T 23444-503H	
Unit AT1	- ATTENUATOR BOARD	Issue 3	
29. When	ordering, prefix circuit reference with A	r1	
	Complete unit	44828-448N	
C1 C2	CAP CER .039UF 50V 20% CHIP CAP CER .039UF 50V 20% CHIP	26386-493F 26386-493F	
D1 D2	DIODE HOT CARR HP5082-2811 DIODE HOT CARR HP5082-2811	28349-008U 28349-008U	
L1	COIL ASSY	44290-750K	
R1 R2 R3 R4 R5	RES CHIP 53R3 1% RES CHIP 790R 1% RES CHIP 53R3 1% RES CHIP 53R3 1% RES CHIP 790R 1%	24681-023S 24681-033C 24681-023S 24681-023S 24681-033C	

Circuit Ref	Description	Part Number
Unit AT1	- ATTENUATOR BOARD	(Contd.)
R6	RES CHIP 53R3 1%	24681-0238
R7	RES CHIP 53R3 1%	24681-023S
R8	RES CHIP 790R 1%	24681-033C
R9	RES CHIP 53R3 1%	24681-0235
R10	RES CHIP 61R1 1%	24681-024W
R11	RES CHIP 247R 1%	24681-030P
R12	RES CHIP 61R1 1%	24681-024W
R13	RES CHIP 96R3 2%	24681-027P
R14	RES CHIP 71R2 1%	24681-025D
R15	RES CHIP 96R3 2%	24681-027P
R16	RES CHIP 470R 5%	24681-046N
R17	RES CHIP 470R 5%	24681-046N
R18	RES CHIP 51R 5%	24681-045Y
R19	RES CHIP 51R 5%	24681-045Y
R20	RES CC 150R 1/8W 5%	24331-990D
RLF	SW REED 1NO REED	23486-452P
SA	SW MICRO 1P2W PLUNGR OPER	23483-144G
SB	SW MICRO 1P2W PLUNGR OPER	23483-144G
SC	SW MICRO 1P2W PLUNGR OPER	23483-144G
SD	SW MICRO 1P2W PLUNGR OPER	23483-144G
SE	SW MICRO 1P2W PLUNGR OPER	23483-144G
SF	SW MICRO 1P2W PLUNGR OPER	23483-144G
SH	SW MICRO 1P2W PLUNGR OPER	23483-144G
SJ	SW MICRO 1P2W PLUNGR OPER	23483-144G
SK	SW MICRO 1P2W PLUNGR OPER	23483-144G
SL	SW MICRO 1P2W PLUNGR OPER	23483-144G
X2	RELAY TUBE	35902-731V

Circuit Ref	Description	Pa Num	art
Unit AT2	- ATTENUATOR CONTROL	Issue	3
30. When	ordering, prefix circuit reference with	AT2	
	Complete unit	44828-4	45E
C1 C2 C3 C4 C5	CAP CER 47PF 63V 5% PLATE CAP TANT .47UF 35V 20% BEAD CAP CER 1.8PF 63V .5PF PLATE CAP CER 0.01UF 100V 20% DISC CAP TANT 4.7UF 35V 20% BEAD	26343-4 26486-2 26343-4 26383-0 26486-2	56C 55L
D1 D2 D3 D4 D5	DIODE SIL 1N4148 100V JUNC DIODE SIL 1N4148 100V JUNC DIODE ZENER BZY88C10 10V 5% DIODE ZENER BZY88C24 24V DIODE ZENER BZY88C24 24V	28336-6' 28371-8' 28373-2' 28373-2'	76J 43E 71J
D6 D7 D8 D9 D10	DIODE ZENER BZY88C24 24V DIODE ZENER BZY88C24 24V DIODE ZENER BZY88C24 24V DIODE SIL 1N4148 100V JUNC DIODE LED LLL37 2.4V YELLOW	28373-2° 28373-2° 28373-2° 28336-6° 28624-1°	71J 71J 76J
D11	DIODE RECT 1N4004 400V	28357-02	28K
IC1 IC2 IC3 IC4	ICA AMP CA3130S GP MOS TO99 ICA COMP LM311N DIL8 ICD NOR 74LS02 QUAD 2INP ICD MONO 74LS122 RETR	28461-32 28461-69 28466-2 28468-3	95U 14Y
PLM PLN PLP PLV	CON PART PCB POST SQUARE PIN	23435-18 23435-18 23435-18 23435-18	88v 88v
R1 R2 R3 R4 R5	RES MF 100K 1/4W 2% RES MF 47K 1/4W 2% RES MF 100K 1/4W 2% RES MF 10K 1/4W 2% RES MF 10K 1/4W 2%	24773-33 24773-33 24773-23 24773-29	13H 21L 97M
R6 R7 R8 R9 R10	RES MF 24K 1/4W 2% RES MF 1K3 1/4W 2% RES MF 3K9 1/4W 2% RES MF 10K 1/4W 2% RES MF 10K 1/4W 2%	24773-30 24773-20 24773-20 24773-20 24773-20	76E 87V 97M
R11 R12 R13 R14 R15	RES MF 510R 1/4W 2% RES MF 47K 1/4W 2% RES MF 10K 1/4W 2% RES MF 24K 1/4W 2% RES MF 3K9 1/4W 2%	24773-20 24773-3 24773-20 24773-20 24773-20	13H 97M 06B
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Circuit Ref	Description	Part Number
Unit AT2	- ATTENUATOR CONTROL	(Contd.)
R16 R17	RES MF 200R 1/4W 2% RES MF 10K 1/4W 2%	24773-256S 24773-297M
TR1 TR2 TR3	TRANS PNP SIL BC308 25V TRANS NPN SIL BFY51 60V TRANS PNP SIL 2N2905 40V	28433-455R 28455-827T 28434-879X

MECHANICAL COMPONENTS

31. Order without prefix.

Fig. 1 Item	Description	Part no.
I 2	Bottom outer cover Front panel switch caps, marked:-	35903-279В
۷	STORE RECALL MOD OSC	37590-323X 37590-324M 37590-371U
	MOD ALC INCREMENT CARRIER FREQ FM AM	37590-372Y 37590-373N 37590-374L 37590-375J 37590-376F
	RF LEVEL 7 4 1 0	37590-377G 37590-334H 37590-331K 37590-328K 37590-325C
	8 5 2 • 9	37590-335E 37590-332A 37590-329A 37590-326R 37590-336U
	6 3 - MHz/V kHz/mV	37590-333Z 37590-330B 37590-327B 37590-390X 37590-391M
	Hz/µV %/dB INT/EXT TOTAL UP	37590-392C 37590-393R 37590-394B 37590-395K 37590-396A
	ON/OFF RETURN DOWN SECOND FUNCT	37590-397Z 37590-398H 37590-399E 37590-400B
3 4 5 6	Front panel assy. Carrier frequency bezel Modulation and r.f. level bezel Front trim panel Front trim infill	35903-115A 37590-408N 37590-409L 34900-477G 35902-371Z
7 8 9 10	Left-hand side trim infill Left-hand side frame assy. Top outer cover Back foot Stud	35902-384V 35903-314M 35903-278R 37590-514L 37590-223C

Chapter 7

SERVICING DIAGRAMS

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D	
Pars	a .

Circuit notes 1

1 Component values

Symbols

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2a	AE1	Component layout	• • •	4
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3	AMO	Basic module interconnections	• • •	7/8
4	AMO	Control and power supply lines	• • •	9/10
5	AA/BO	RF box 1 interconnections	• • •	11
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6	AA1	LSD loop		13
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7	AA2	Microprocessor system		15
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8	AA3	Frequency standard		17
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25 26a 26 27a 27	ATO AT2 AT2 AGO AGO	10 dB step attenuator	51 52 53 54 55/56

CIRCUIT NOTES

1. Component values

Resistors : Code letter R = ohms, k = kilohms (10³), M = megohms (10⁶).

Capacitors : Code letter m = millifarads (10⁻³), μ = microfarads (10⁻⁶), μ = nanofarads (10⁻⁹), μ = picofarads (10⁻¹²).

Inductors : Code letter H = henrys, m = millihenrys (10⁻³),

 $\mu = \text{microhenrys } (10^{-6}), n = \text{nanohenrys } (10^{-9}).$

† SIC : value selected during test, nominal value shown.

2. Components are marked normally with two, three or four figures according to the accuracy limit $\pm 10\%$, $\pm 1\%$ or $\pm 0.1\%$. The code letter used indicates the multiplier and replaces the decimal point. Because a marking 4m7 could be interpreted as milliohms, millifarads or millihenrys all values are placed near to its related symbol.

3. Symbols

Symbols are based on the provisions of BS 3939 with the following additions:

edge connector

X1

ferrite bead

warning, see page (iv), notes and cautions

Beryllia: health hazard, see page (iv), notes and cautions

warning see page (iv), notes and cautions

Beryllia: health hazard, see page (iv), notes and cautions

and cautions

P printed component

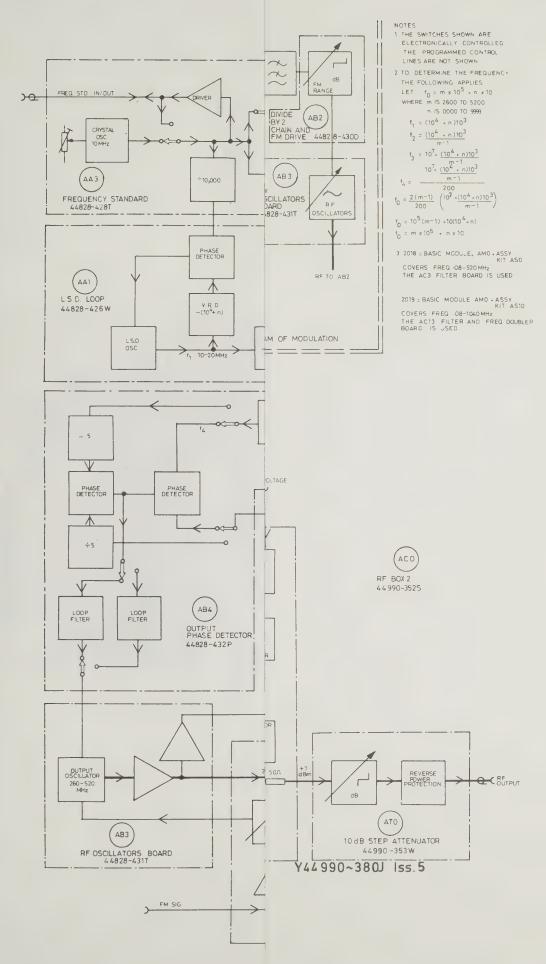


Fig. 1 Sep. 81

Fig.		Title					Page
24a 24	AD4 AD4 AE1	Component layout Keyboard Power supply board (part	of AMO,	···, Fig.	2)		48 49/50
25 26a 26 27a 27	ATO AT2 AT2 AGO AGO	10 dB step attenuator Component layout Attenuator control Component layout GPIB adapter module .	• • •	• • •	• • • •	•••	51 52 53 54 55/56

CIRCUIT NOTES

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Beryllia: health hazard, see page (iv), notes and cautions

unit identification number

P printed component

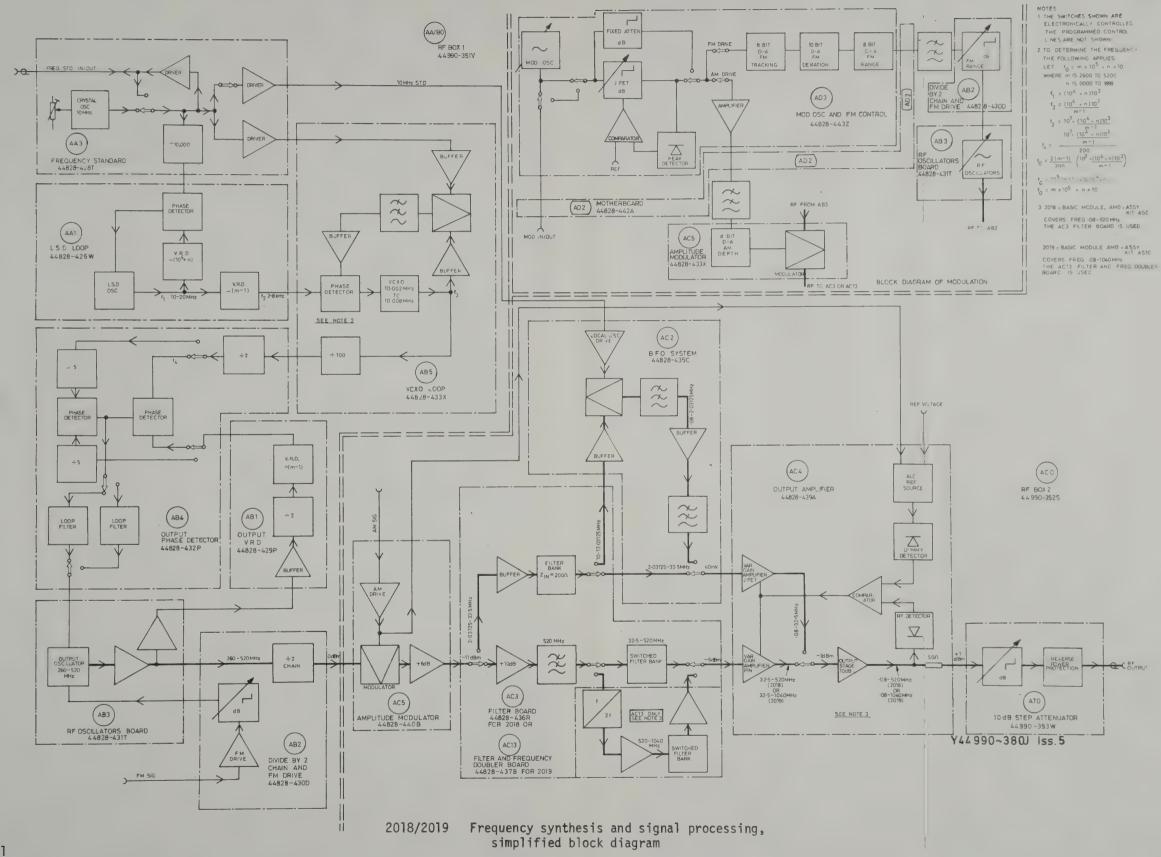
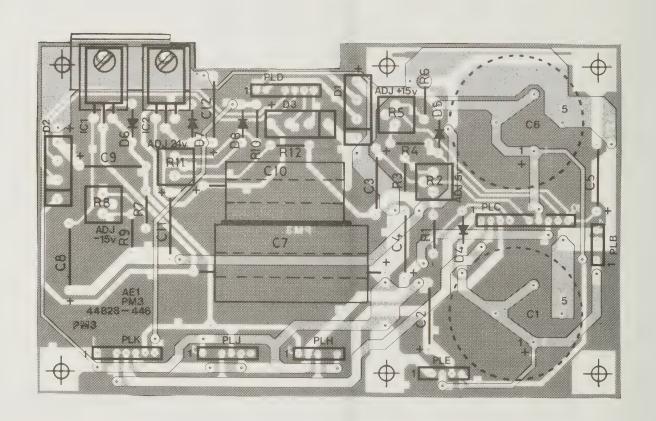
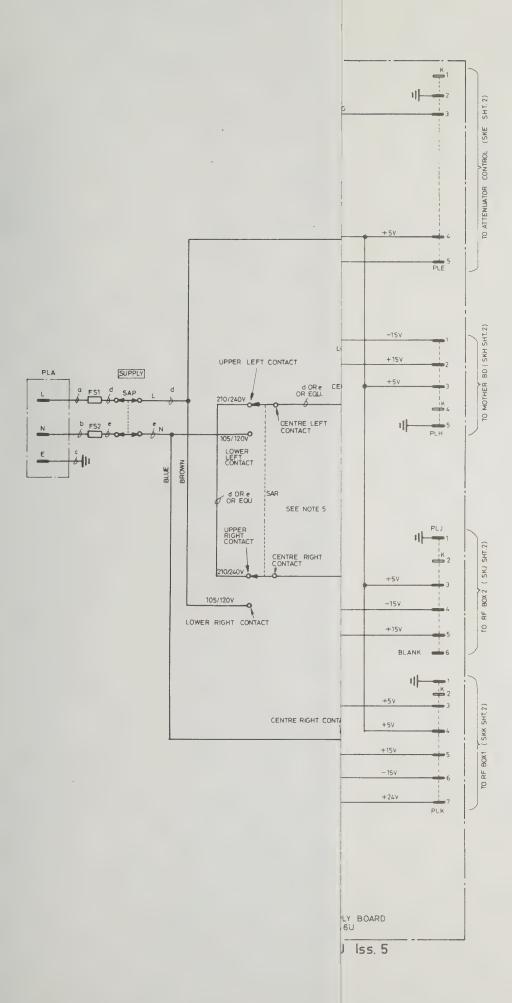


Fig. 1

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Fig. 1 Chap. 7 Page 3







LM350K LM317K VIEW ON PIN SIDE





VIEW FROM TOP

4. WIRES MARKED AS FOLLOWS

a ARE	15410-227T
b ARE c ARE d ARE	15410-2226
CARE	1542 0 - 276U
d ARE	15410-187W
e ARE	15410-182J
6	

UNMARKED WIRES ARE TO M15410-207 S.S.

5 LOOKING FROM FRONT OF INST SWITCH SAR IS TO THE RIGHT OF SAS NOTES OF LEFT AND RIGHT CONTACTS REFER TO THE VIEW FROM THE INST FRONT

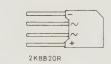
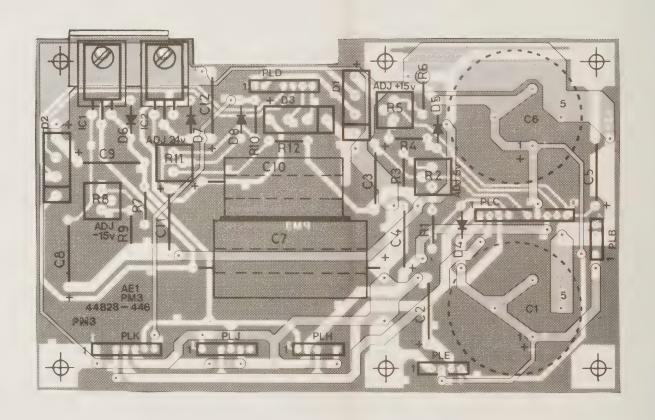
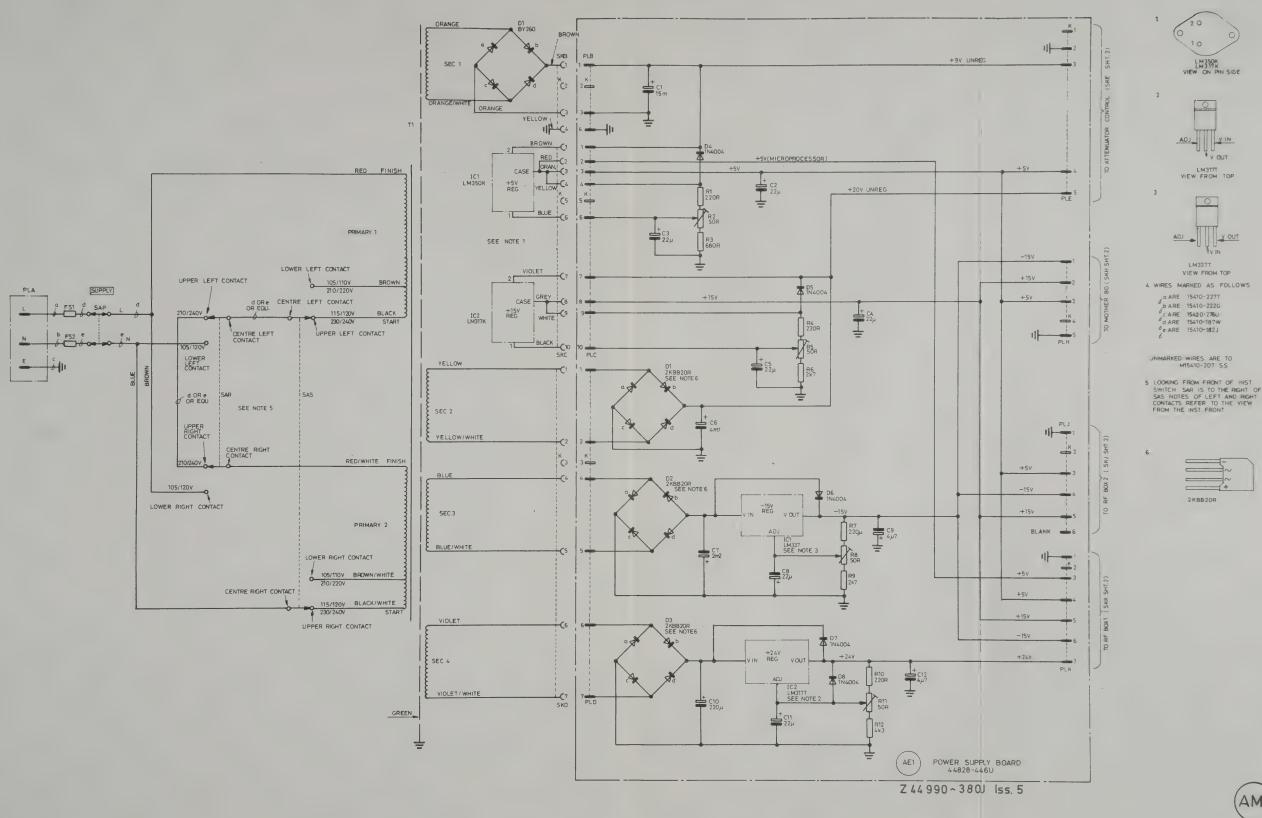




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Power supplies, AMO (includes board AEI)



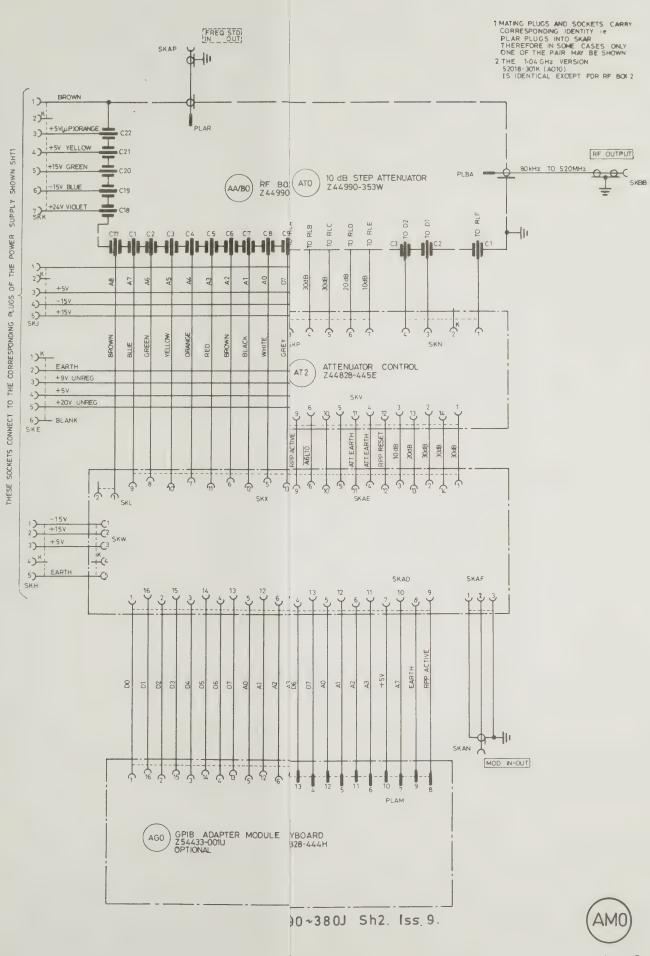


Fig. 3

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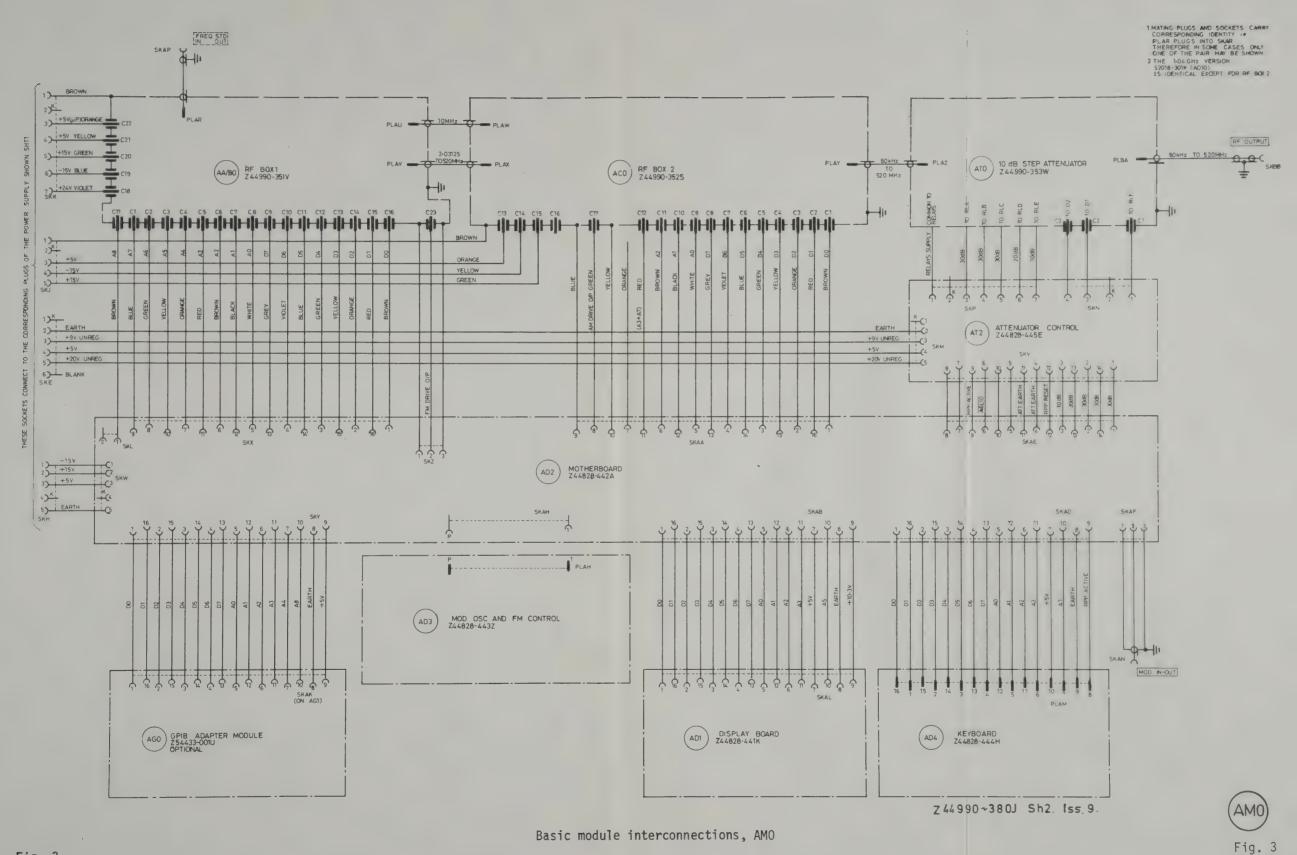
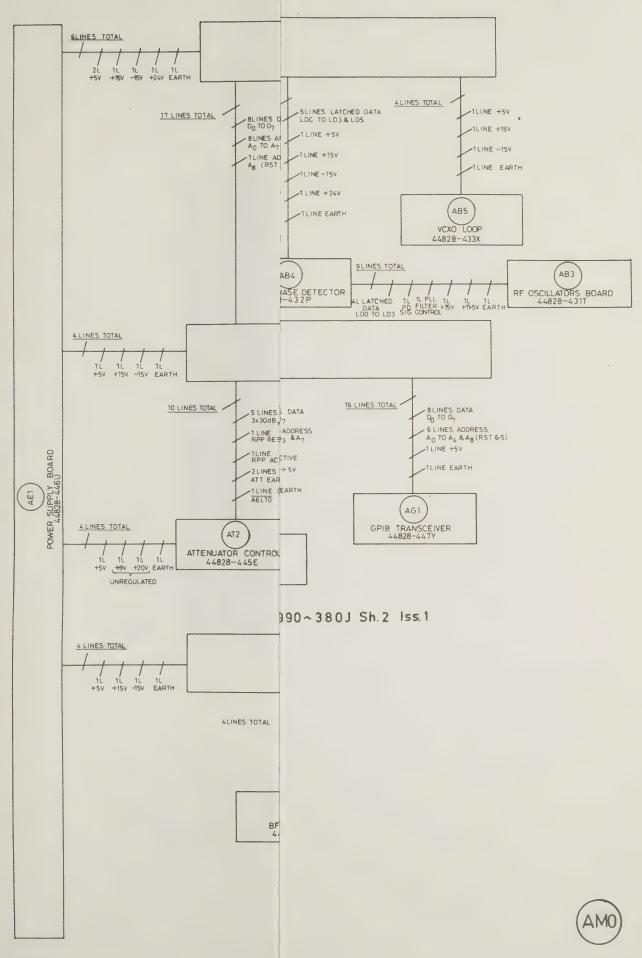


Fig. 3

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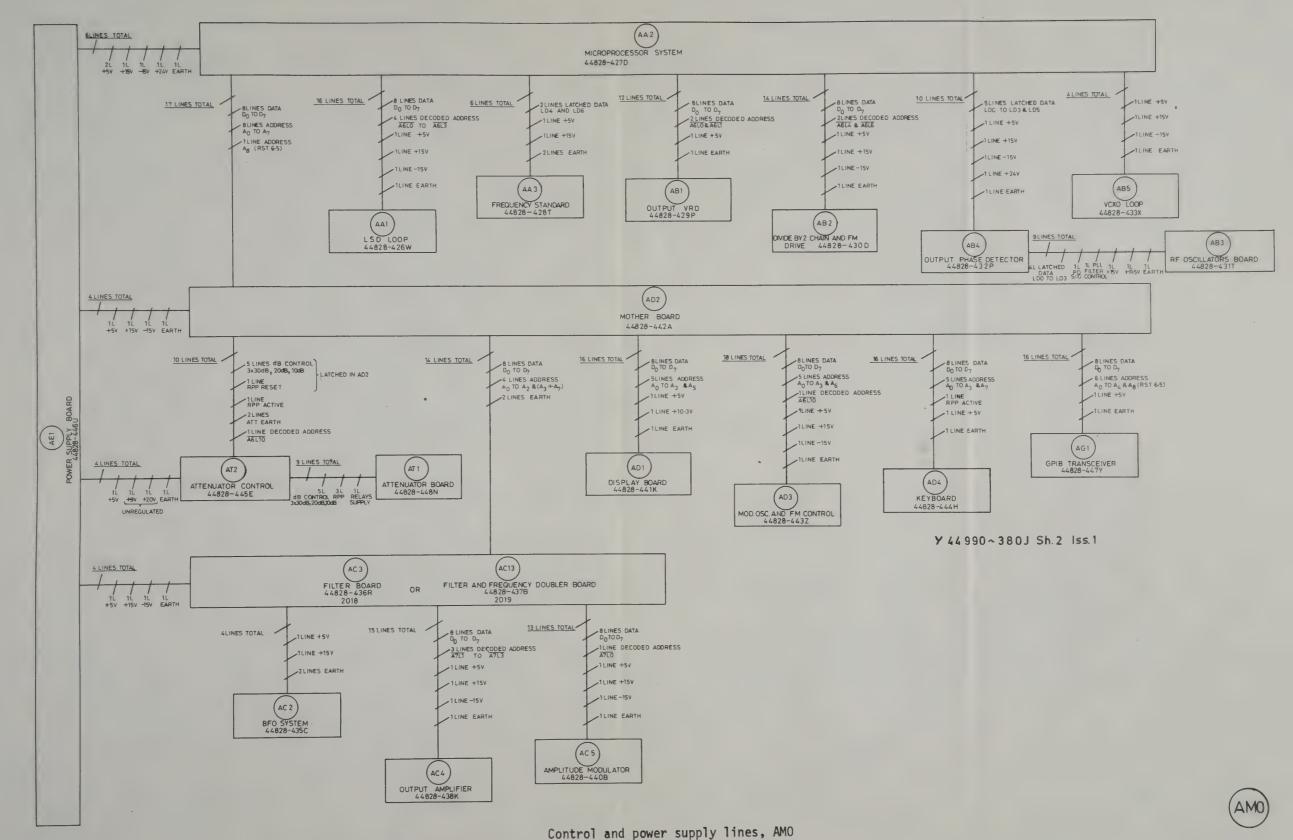




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Fig. 4 Chap. 7 Page 9/10



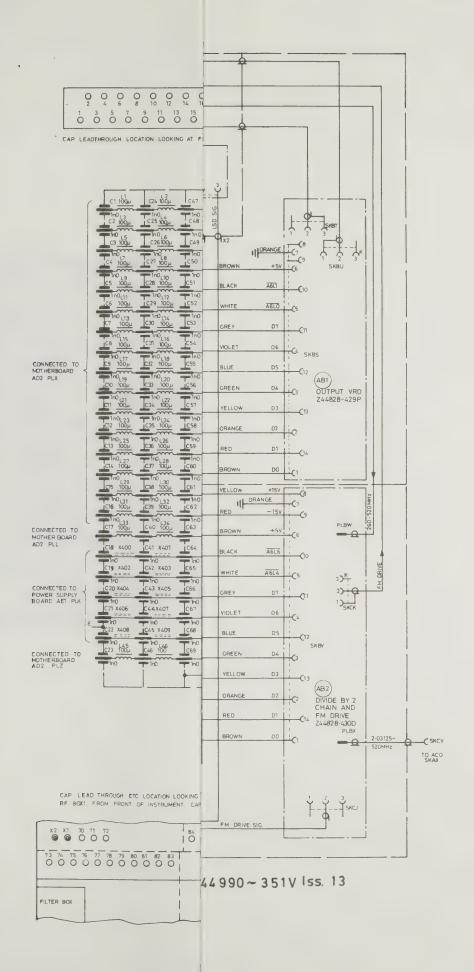
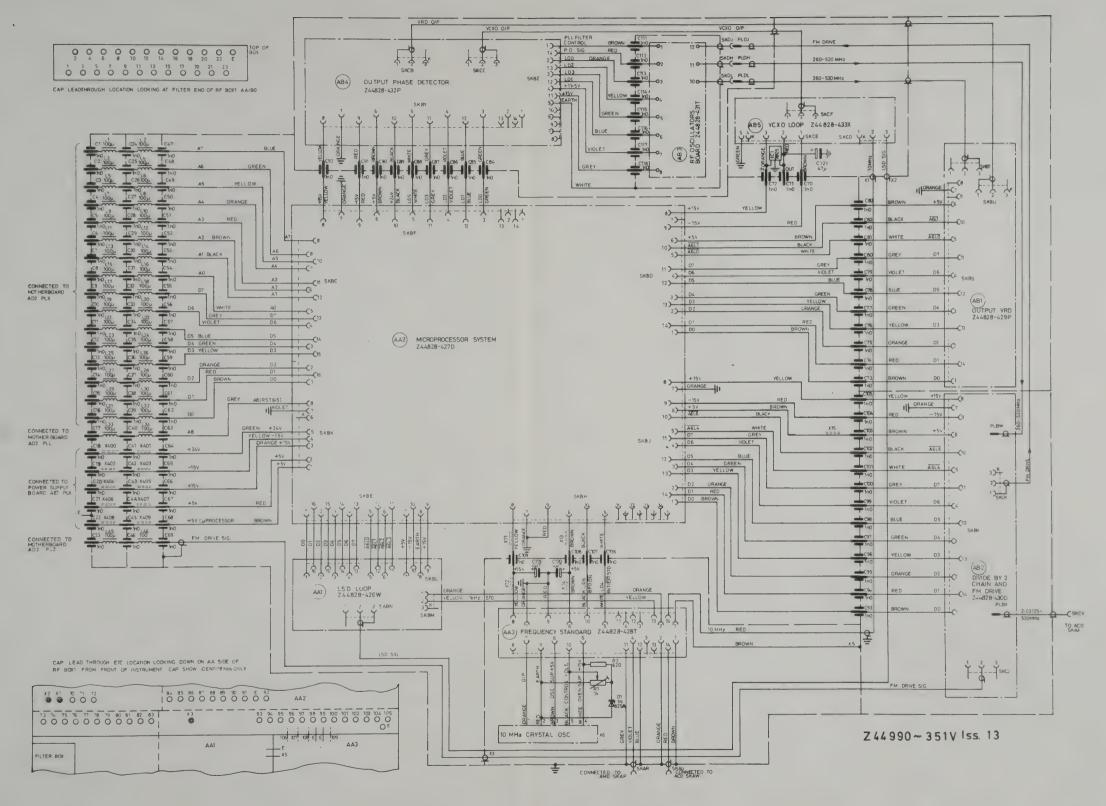




Fig. 5 Chap. 7 Page 11

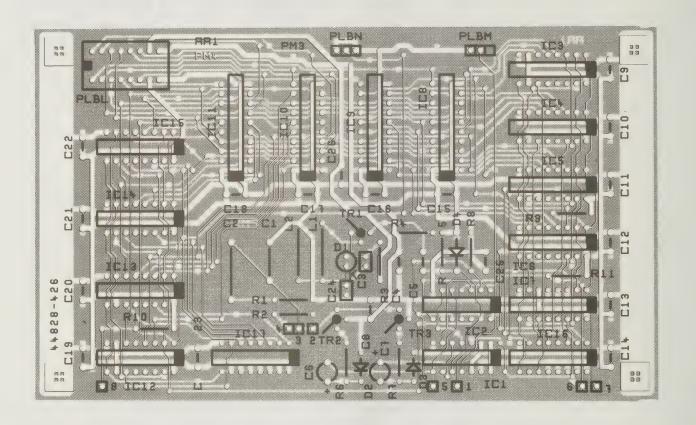


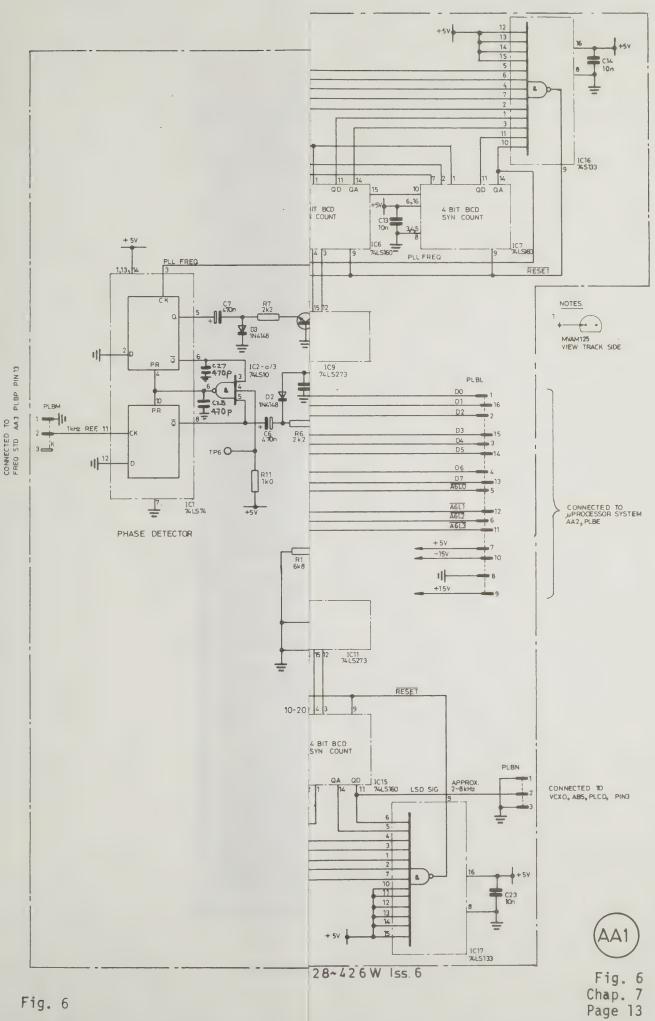


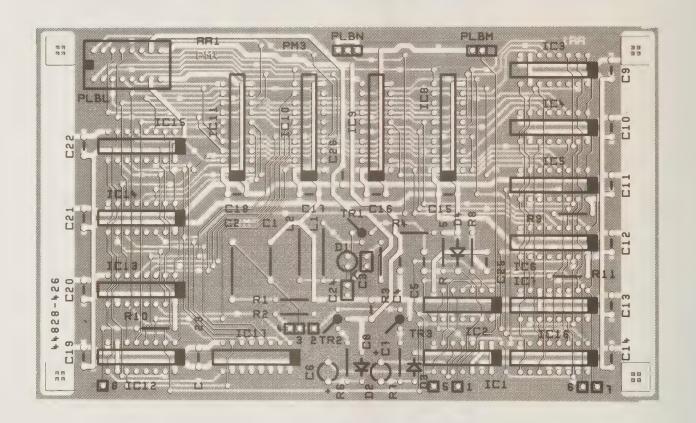
RF box 1 interconnections, AA/BO

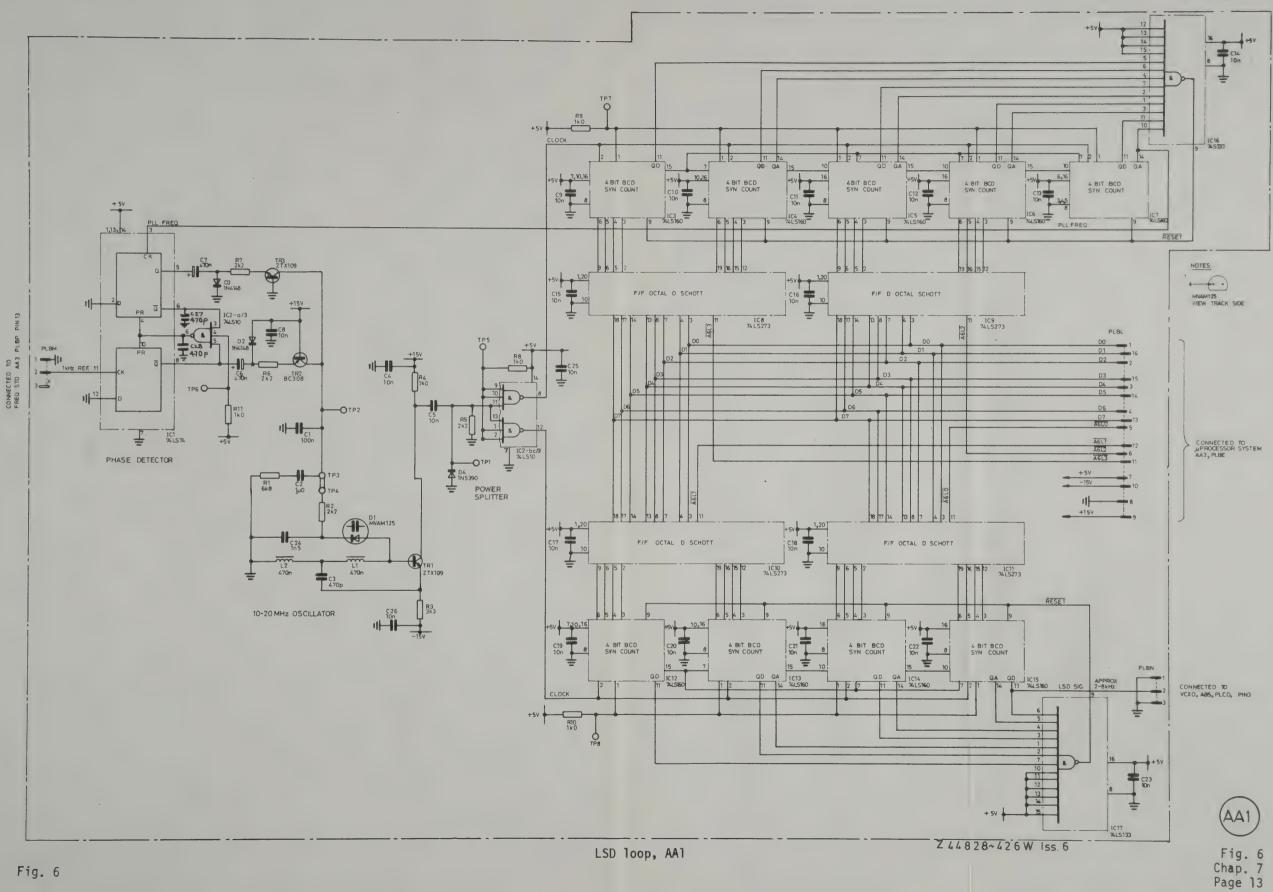
Fig. 5 Sep. 81

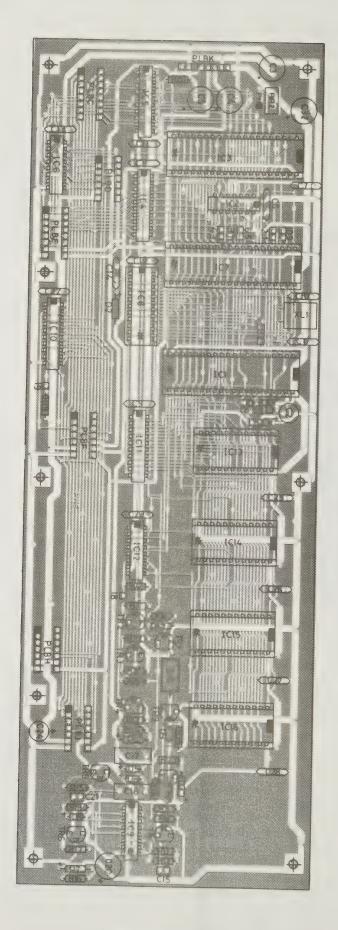
Fig. 5 Page 11



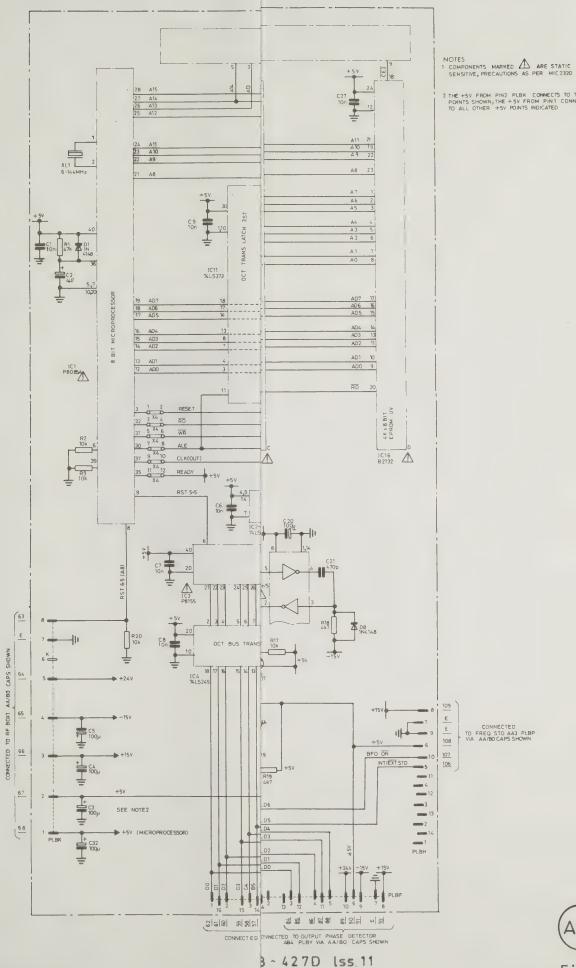






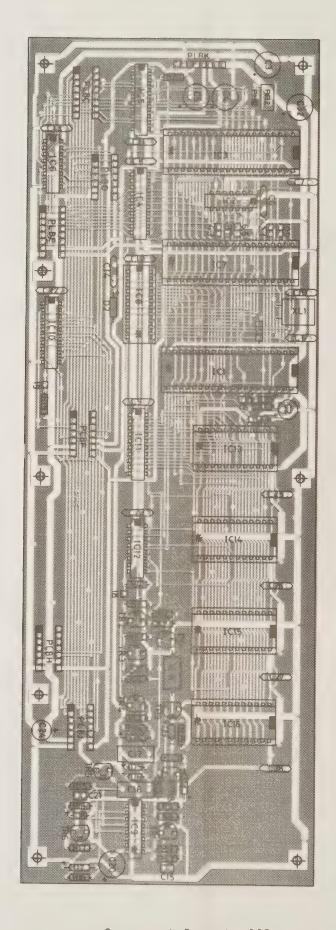


Component layout, AA2



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Fig. 7 Chap. 7 Page 15



Component layout, AA2

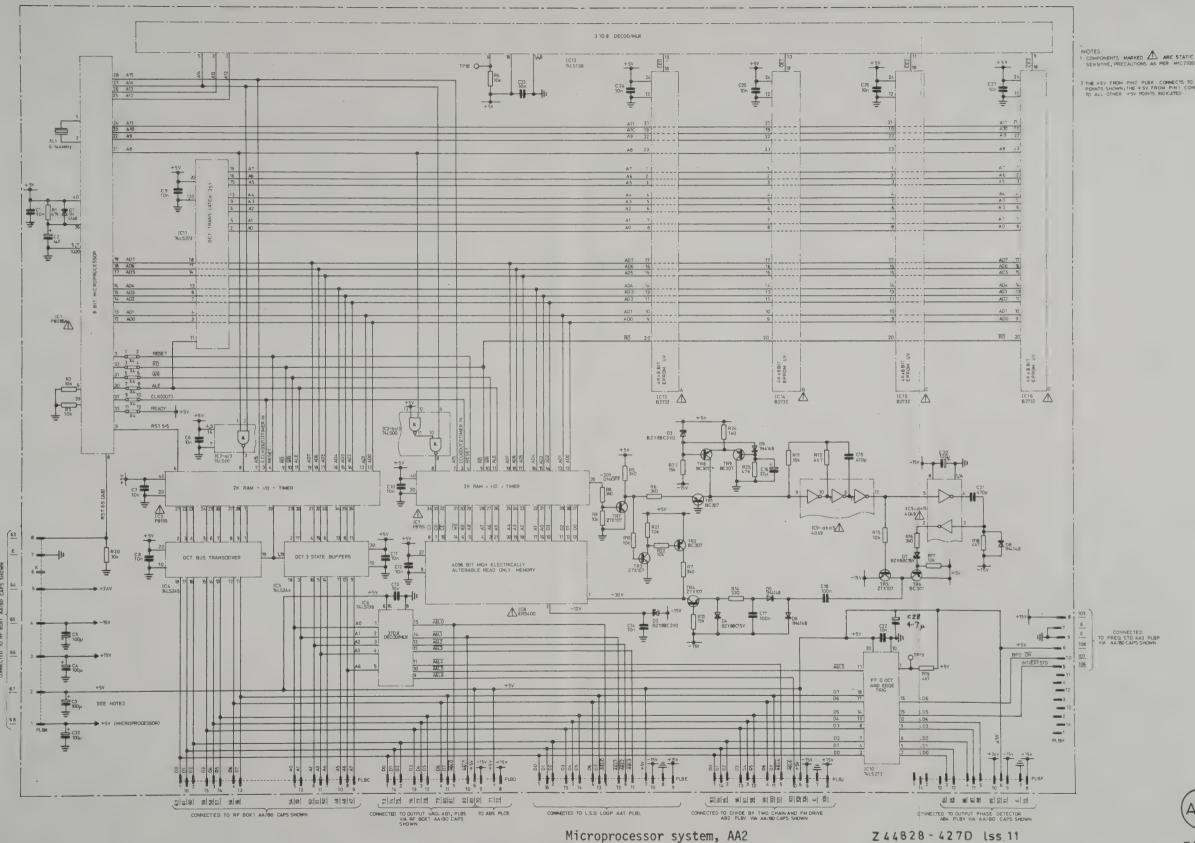
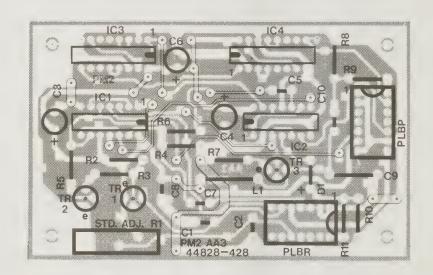


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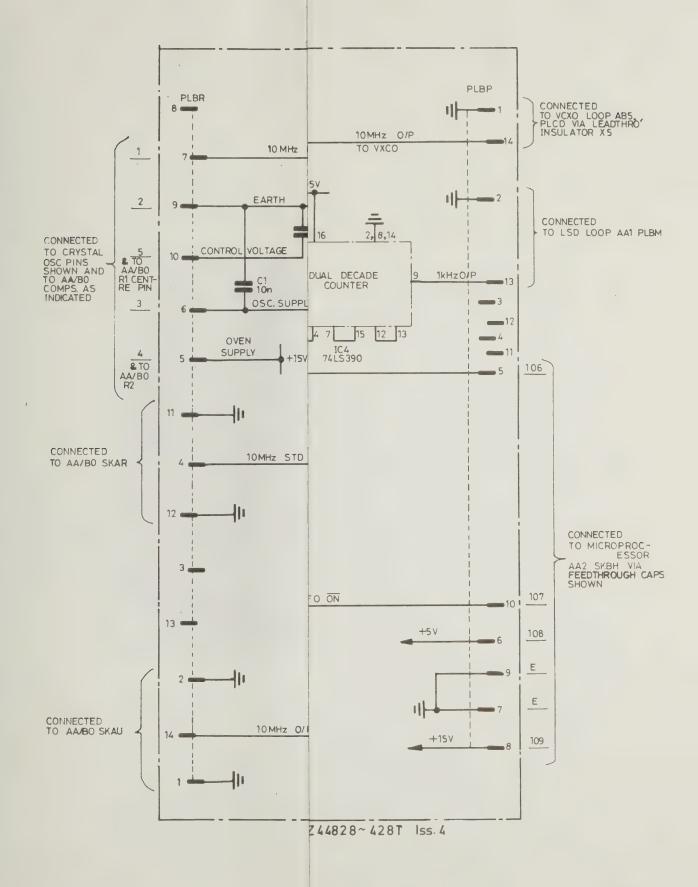
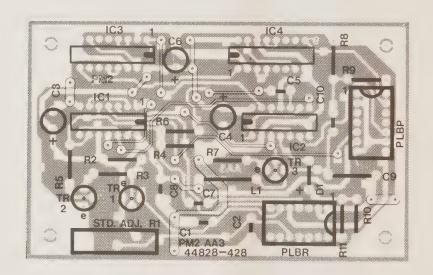






Fig. 8 Chap. 7 Page 17



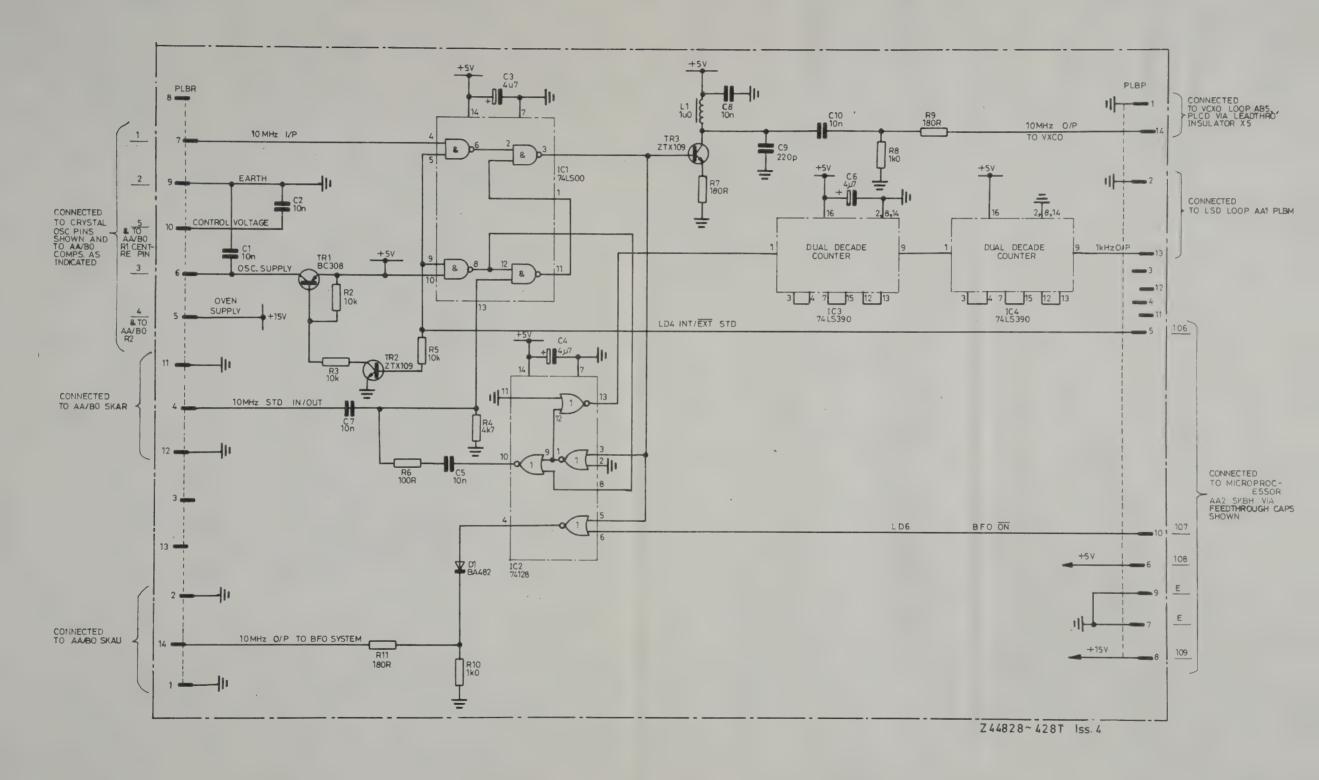
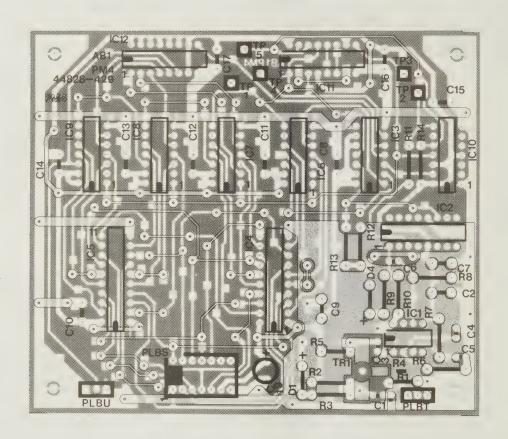


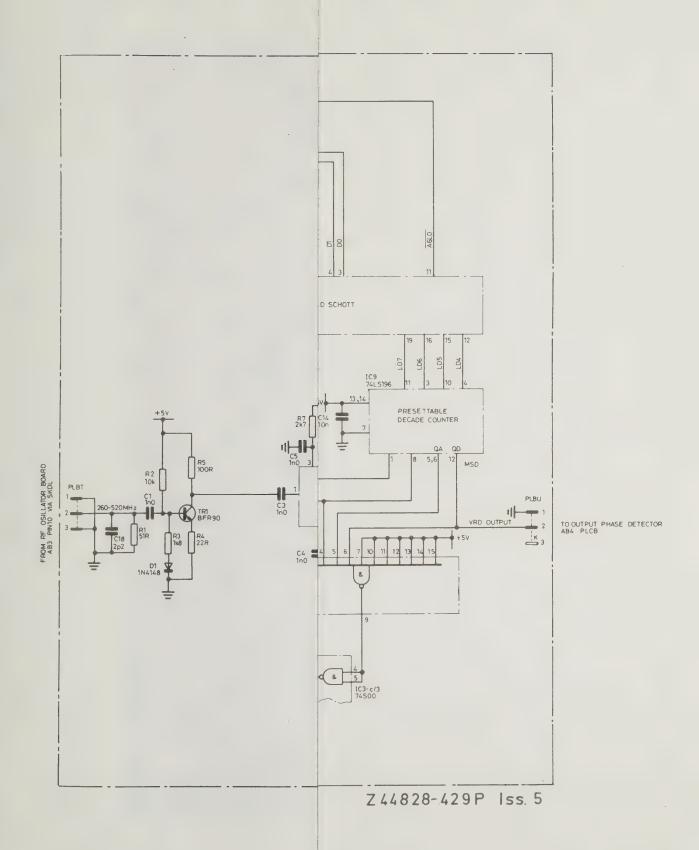


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Frequency standard, AA3

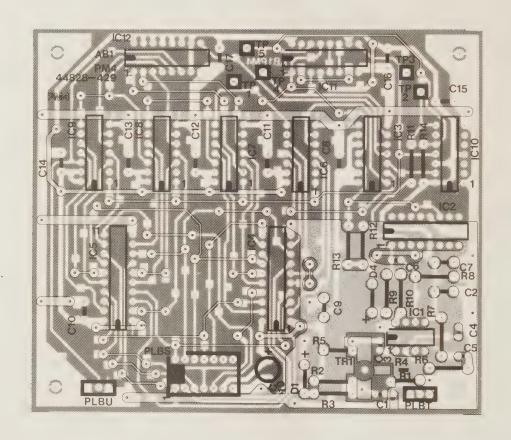


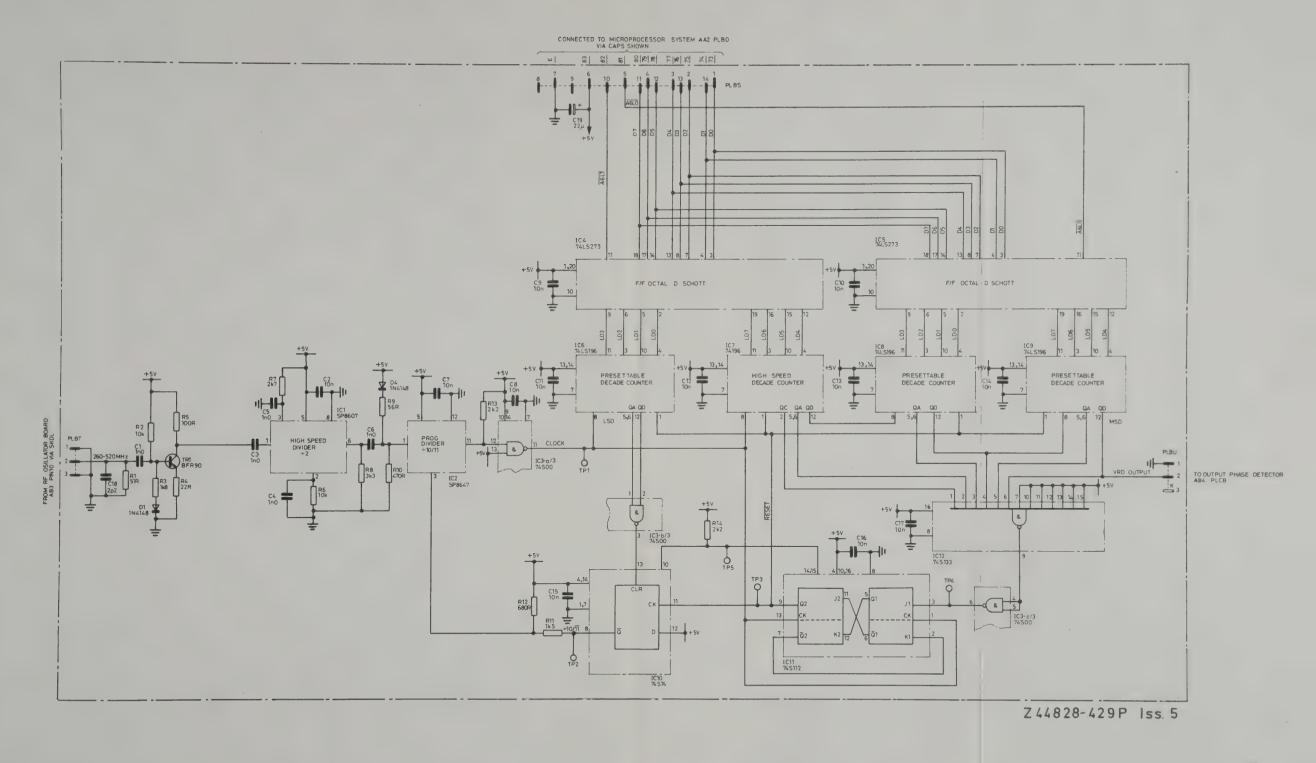


(AB1)

Fig. 9 Chap. 7 Page 19

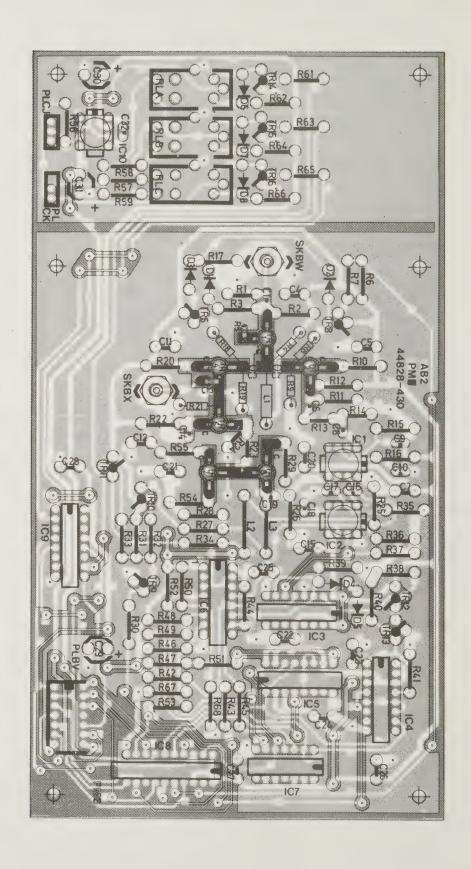
Fig. 9
Sep. 81



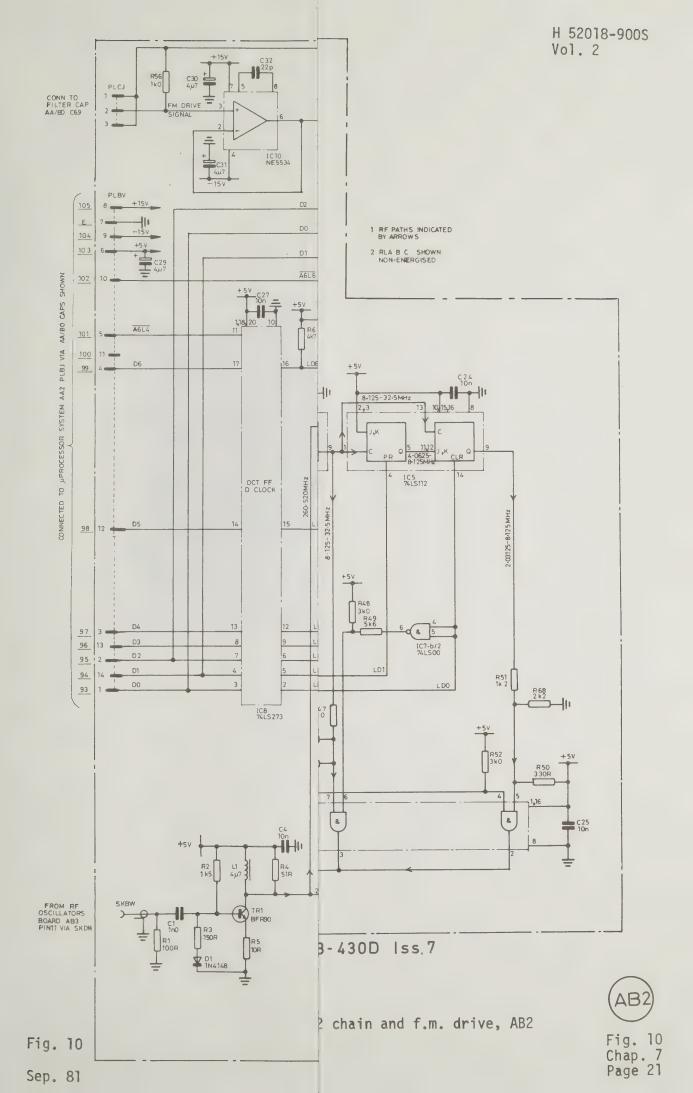


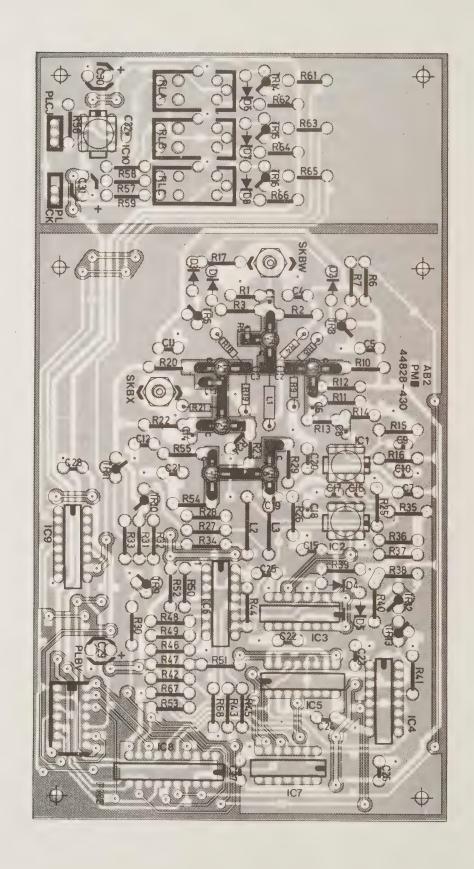
(ABI)

Output v.r.d., AB1

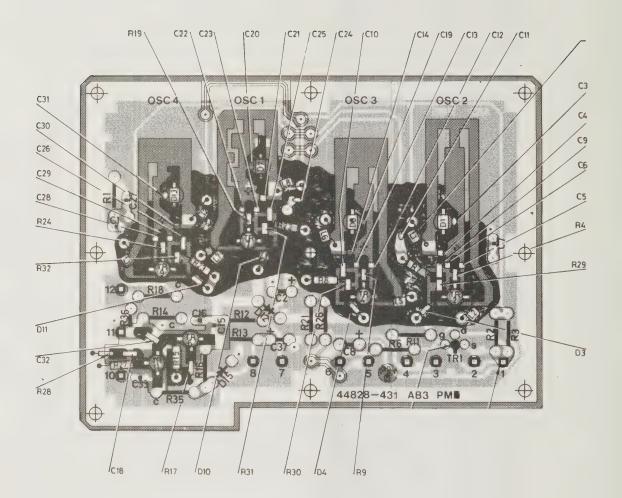


Component layout, AB2





Component layout, AB2



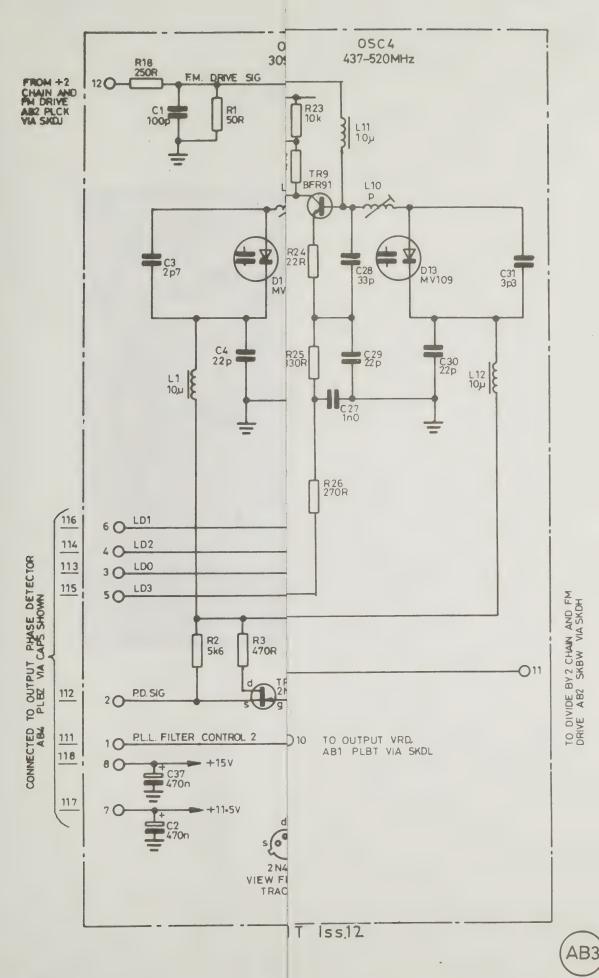
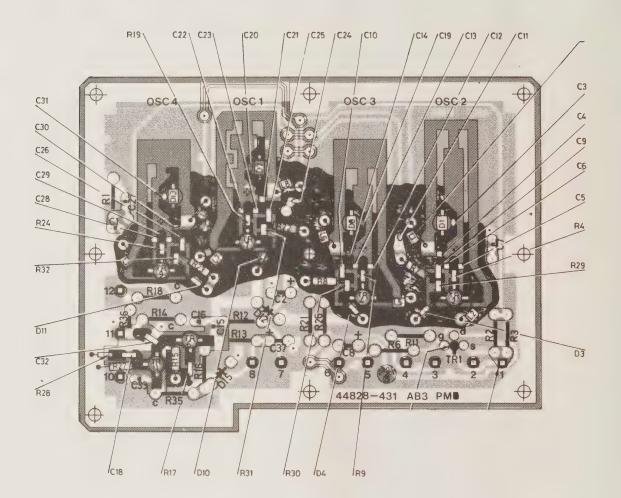
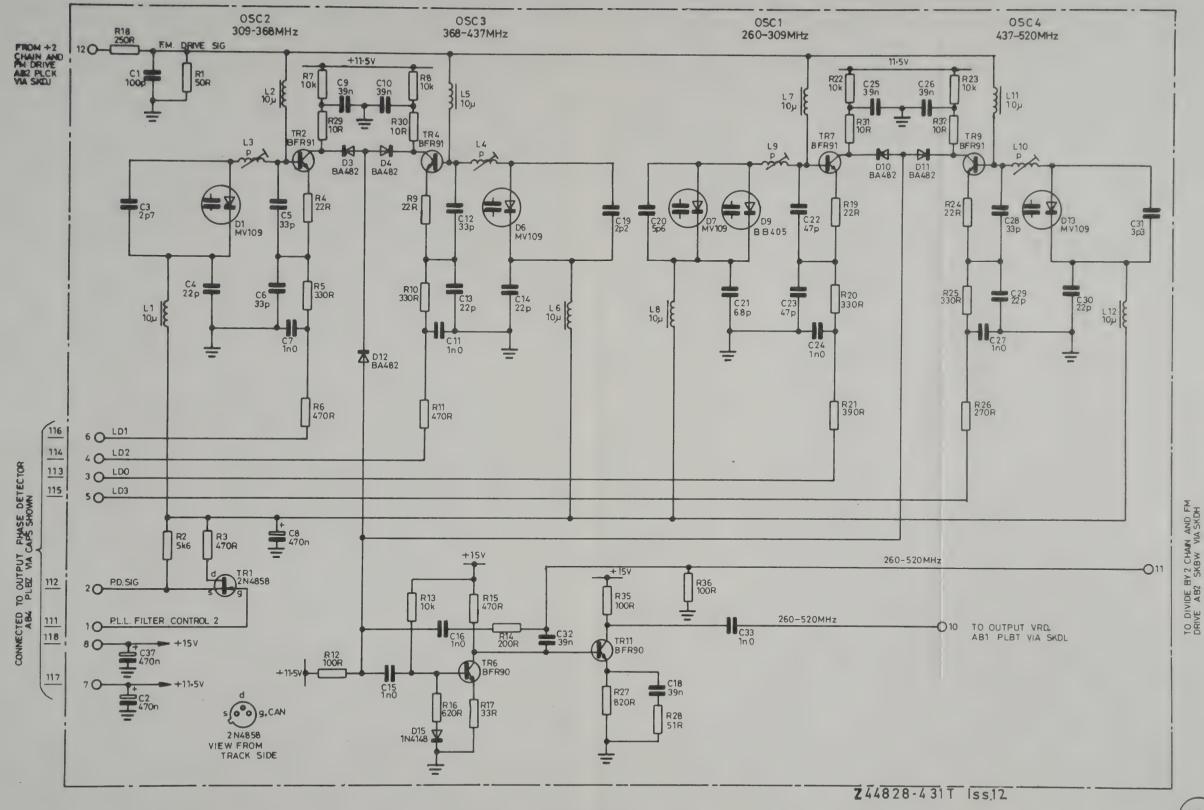


Fig. 11 Sep. 81 Fig. 11 Chap. 7 Page 23

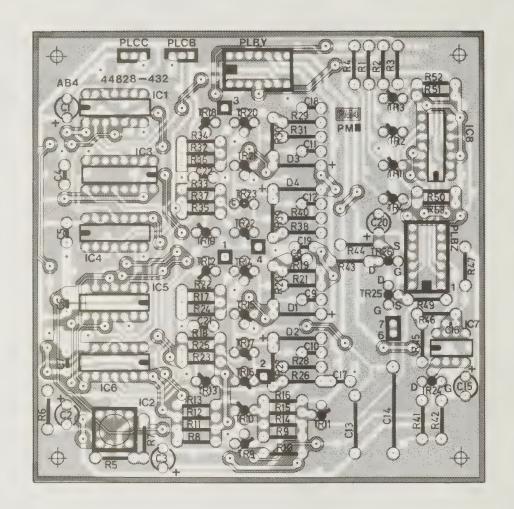


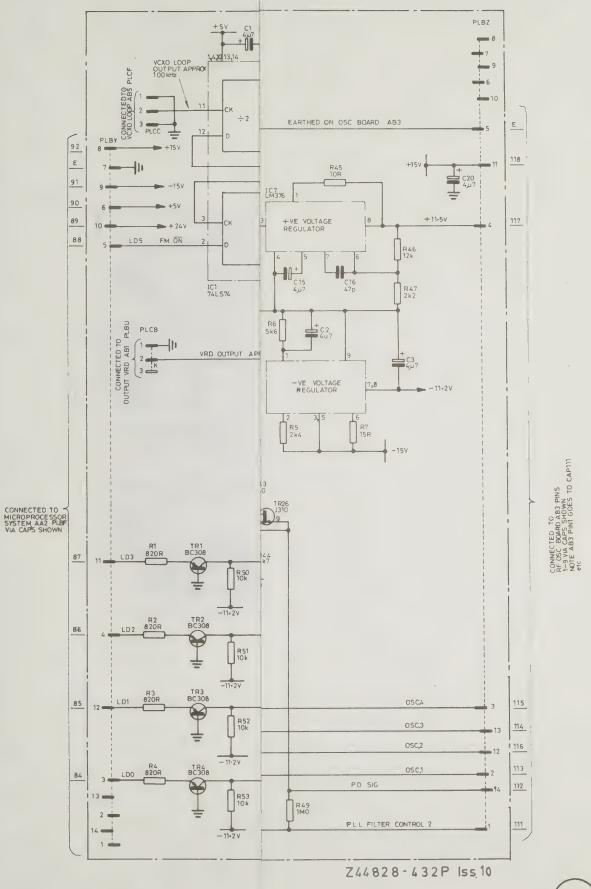


RF oscillators board, AB3

(AB3)

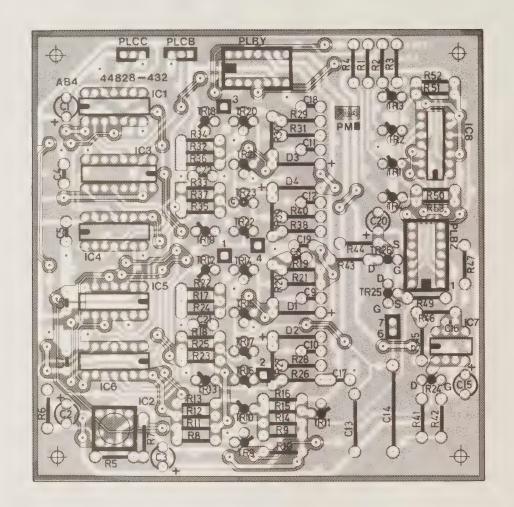
Fig. 11 Chap. 7 Page 23

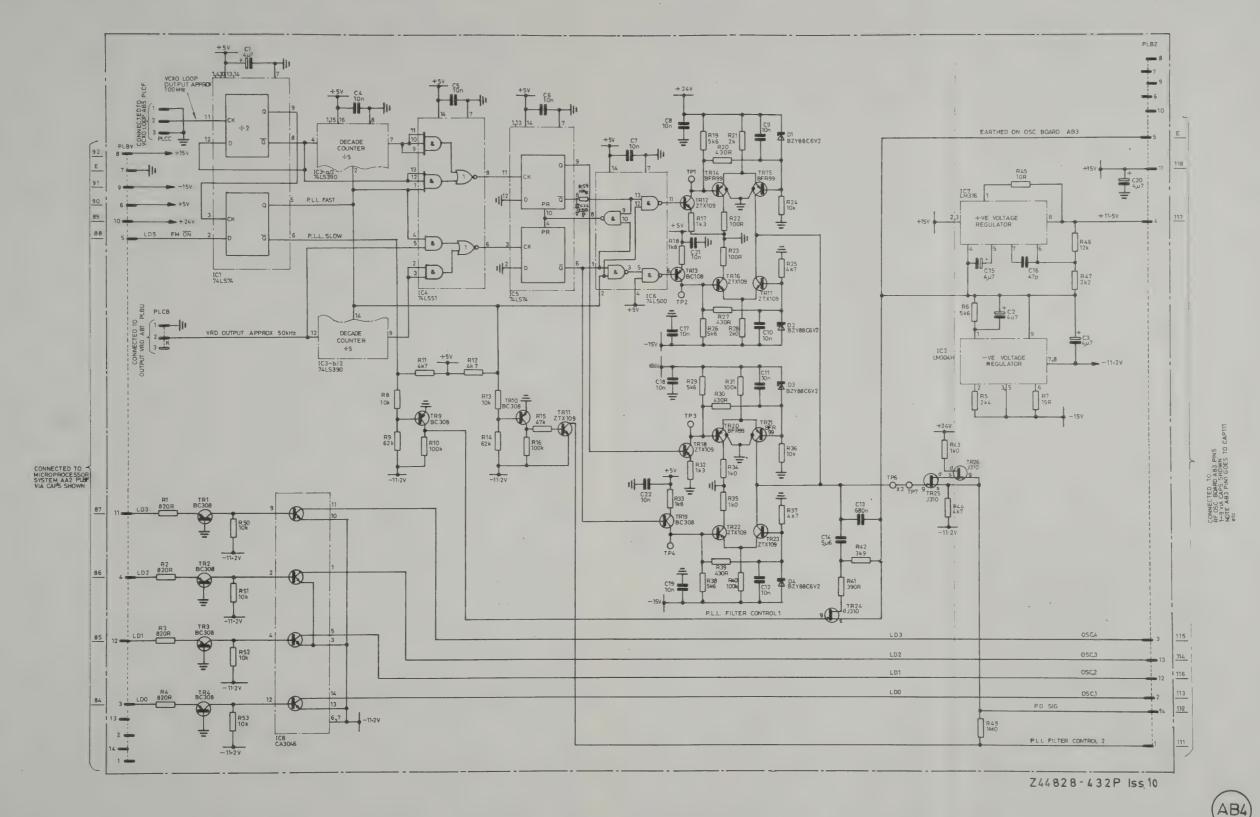




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Fig. 12 Chap. 7 Page 25

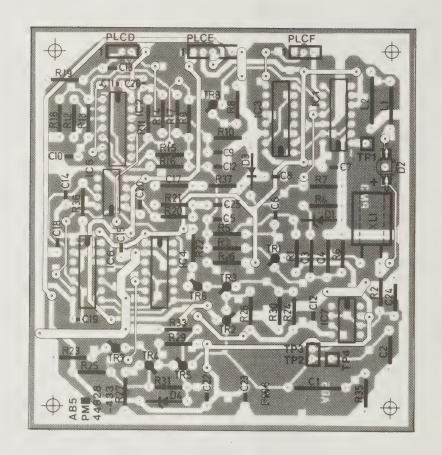




Output phase detector, AB4

Fig. 12 Sep. 81

Fig. 12 Chap. 7 Page 25



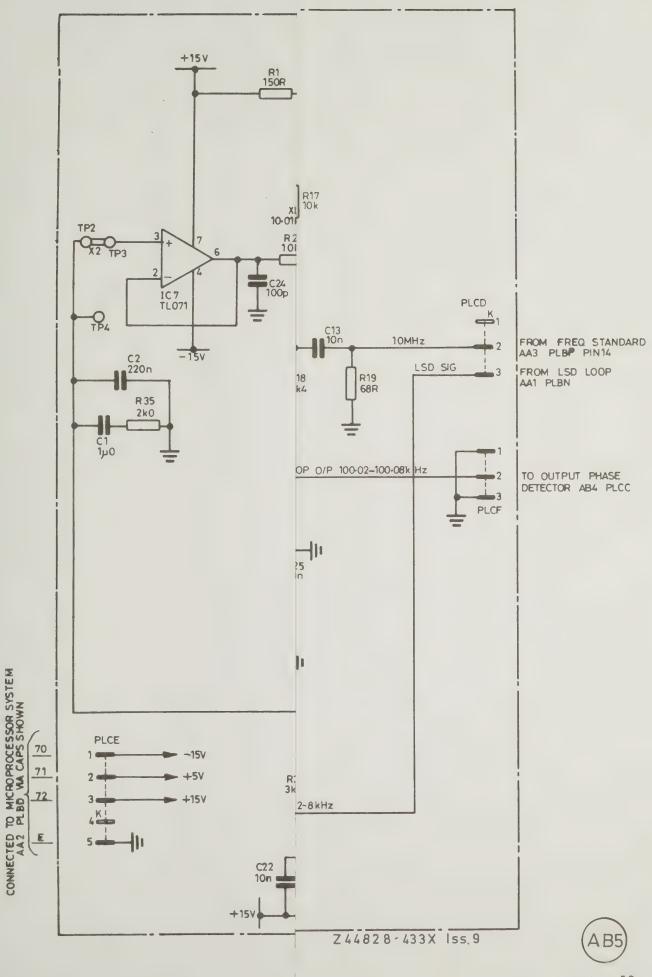


Fig. 13

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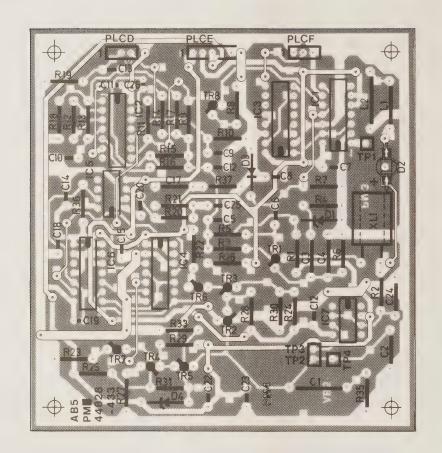
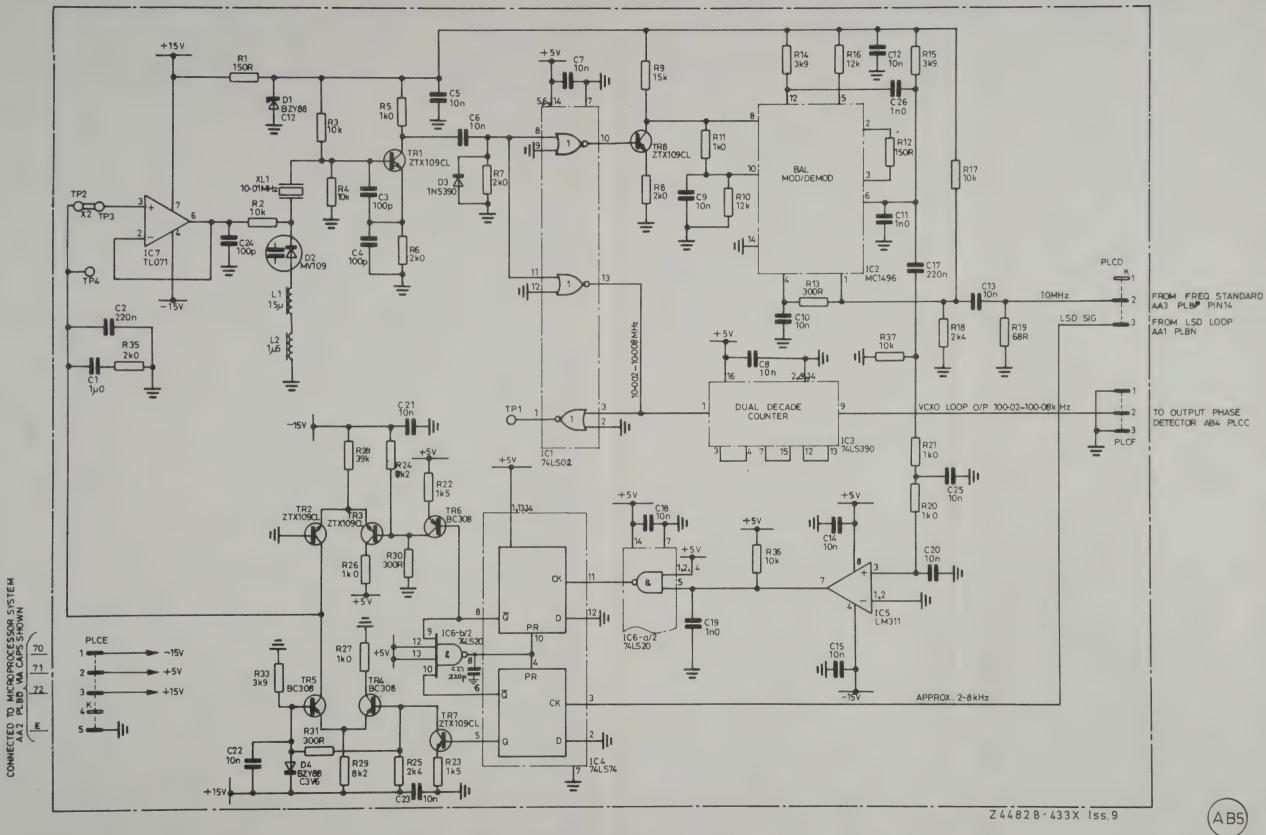


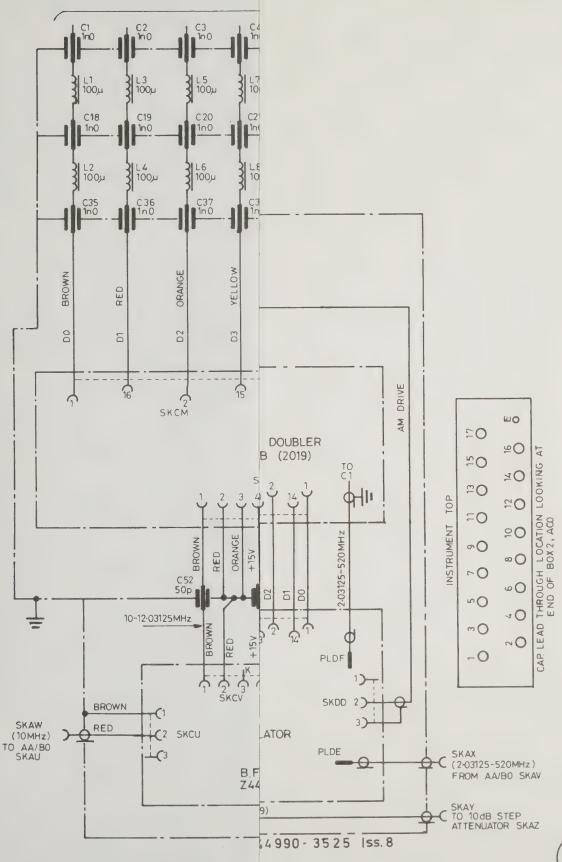
Fig. 13 Chap. 7 Page 27/28



Voltage controlled crystal oscillator loop, AB5

Fig. 13
Sep. 81

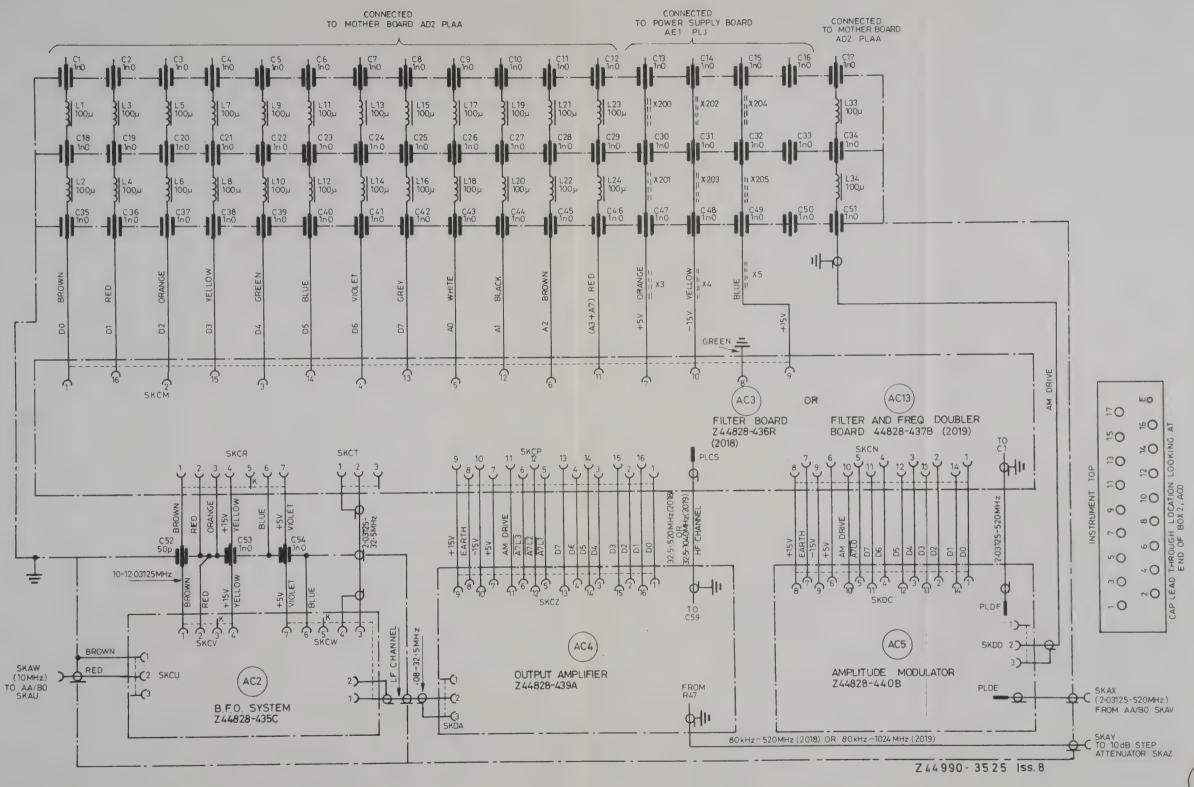




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Fig. 14 Chap. 7 Page 29



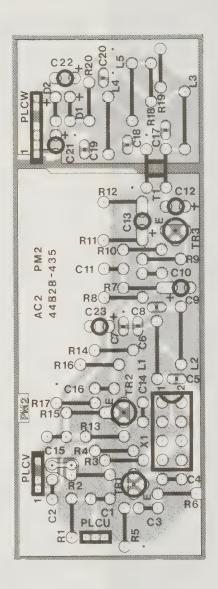


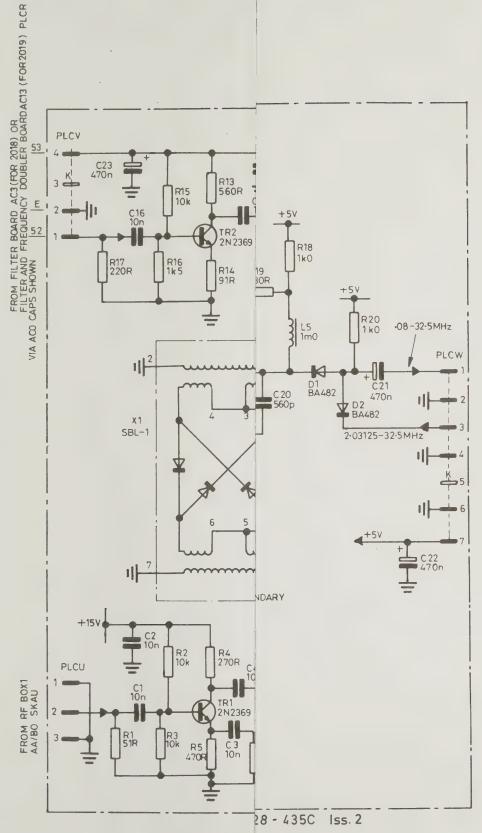
(ACO)

Fig. 14 Chap. 7

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RF box 2 interconnections, ACO





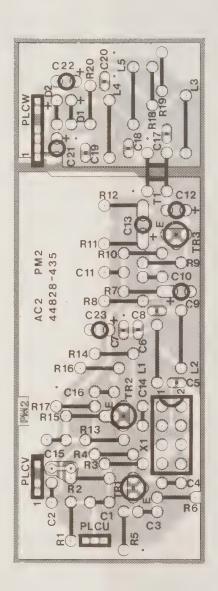
TO O/P AMPLIFIER AC4 PLDA

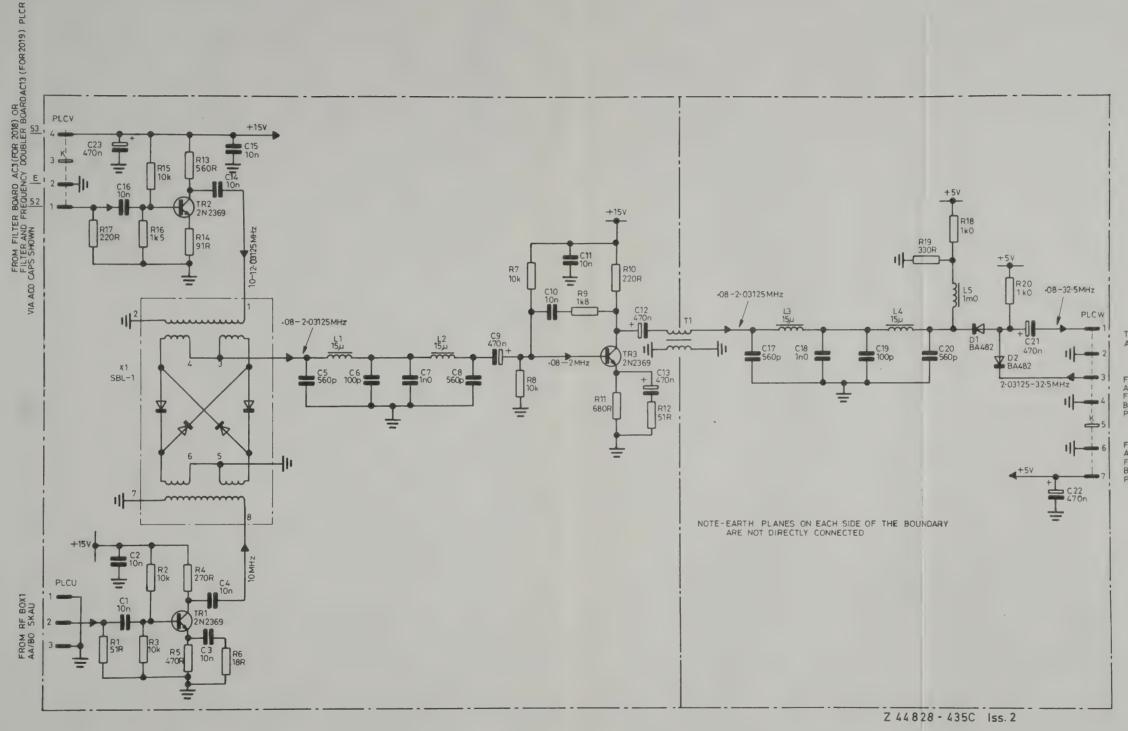
FROM FILTER BOARD AC3(FOR2018) OR FILTER AND FREQ DOUBLER BOARD AC13(FOR 2019) PLCT

FROM FILTER BOARD AC3(FOR 2018) OR FILTER AND FREQ DOUBLER BOARD AC13(FOR 2019) PLCR VIA ACO C54



Fig. 15 Chap. 7 Page 31/32





TO O/P AMPLIFIER AC4 PLDA

FROM FILTER BOARD AC3(FOR 2018) OR FILTER AND FREQ DOUBLER BOARD AC13(FOR 2019) PLCT

FROM FILTER BOARD AC3(FOR 2018) OR FILTER AND FREQ DOUBLER BOARD AC13(FOR 2019) PLCR VIA ACO C54

BFO system, AC2

Fig. 15 Chap. 7 Page 31/32



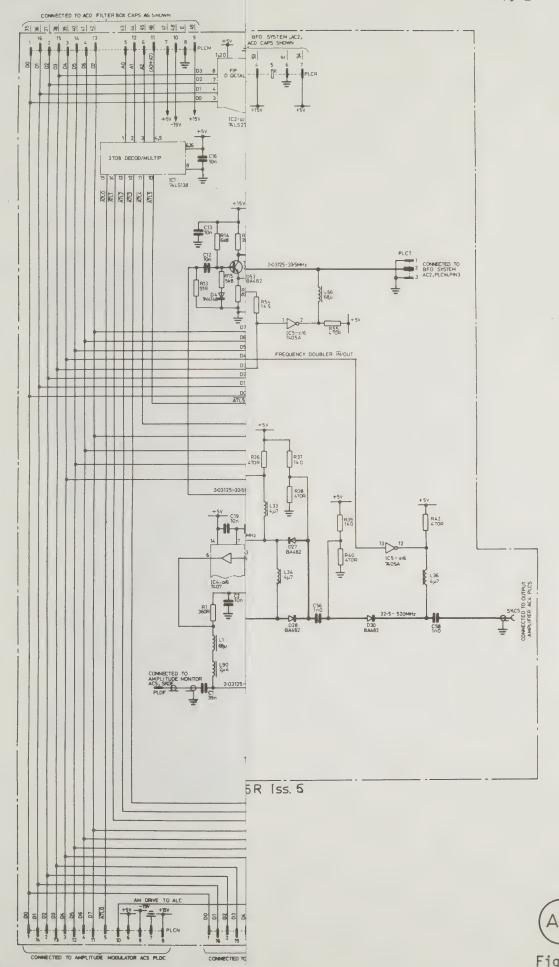


Fig. 16

Fig. 16 Chap. 7 Page 33



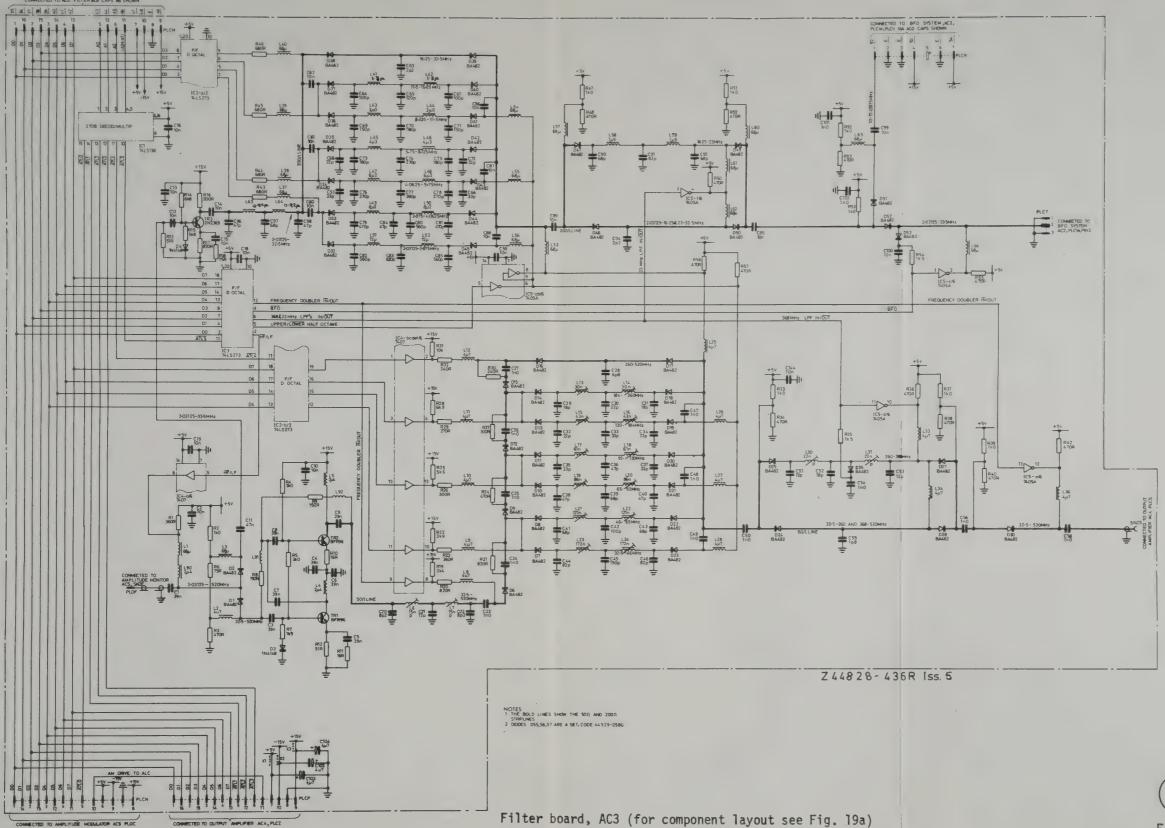
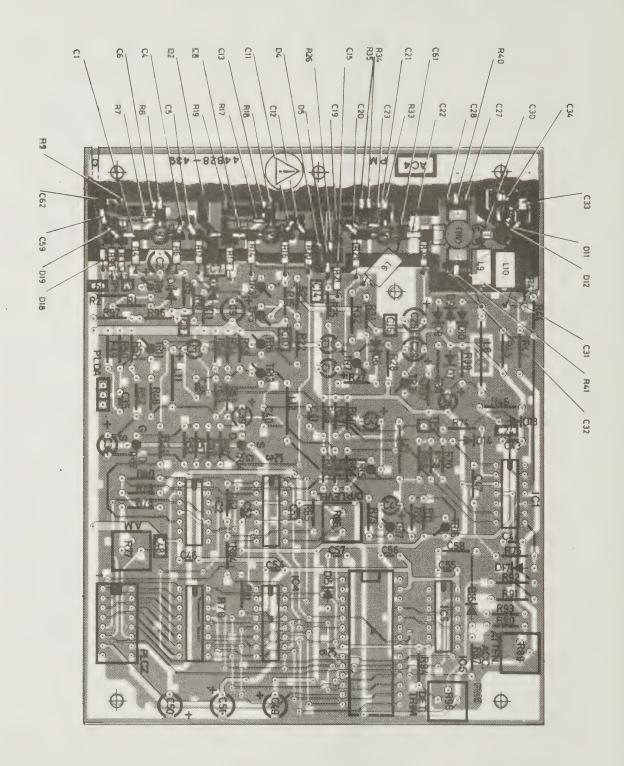


Fig. 16 Sep. 81 Fig. 16 Chap. 7 Page 33



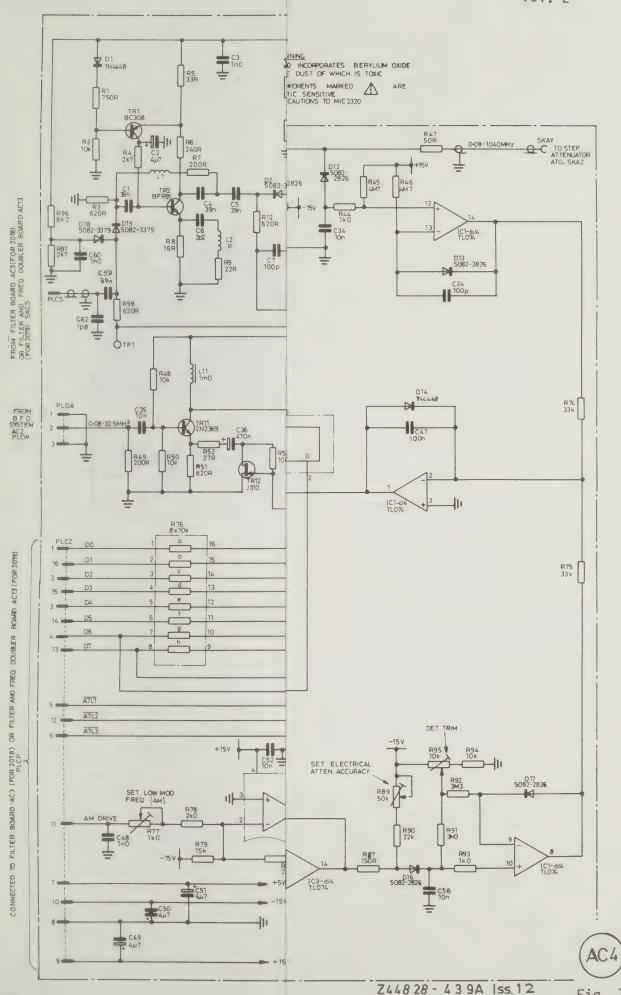
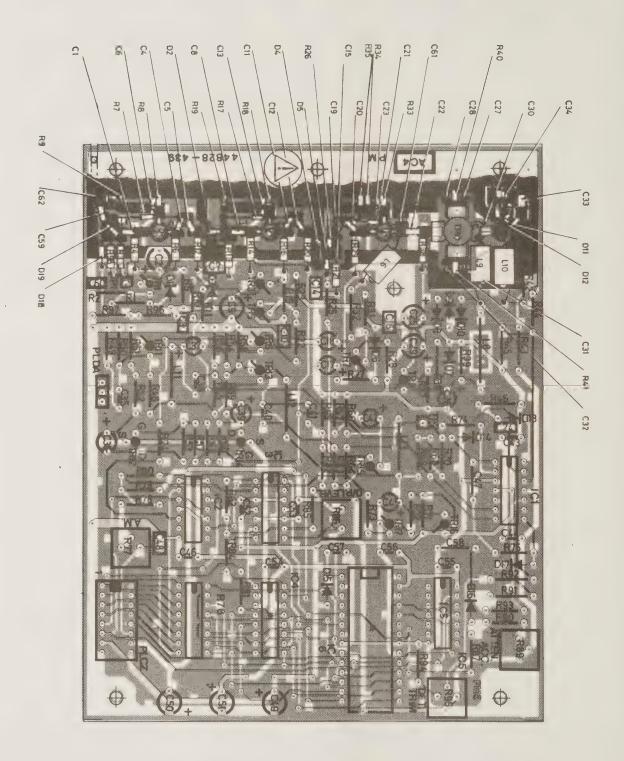
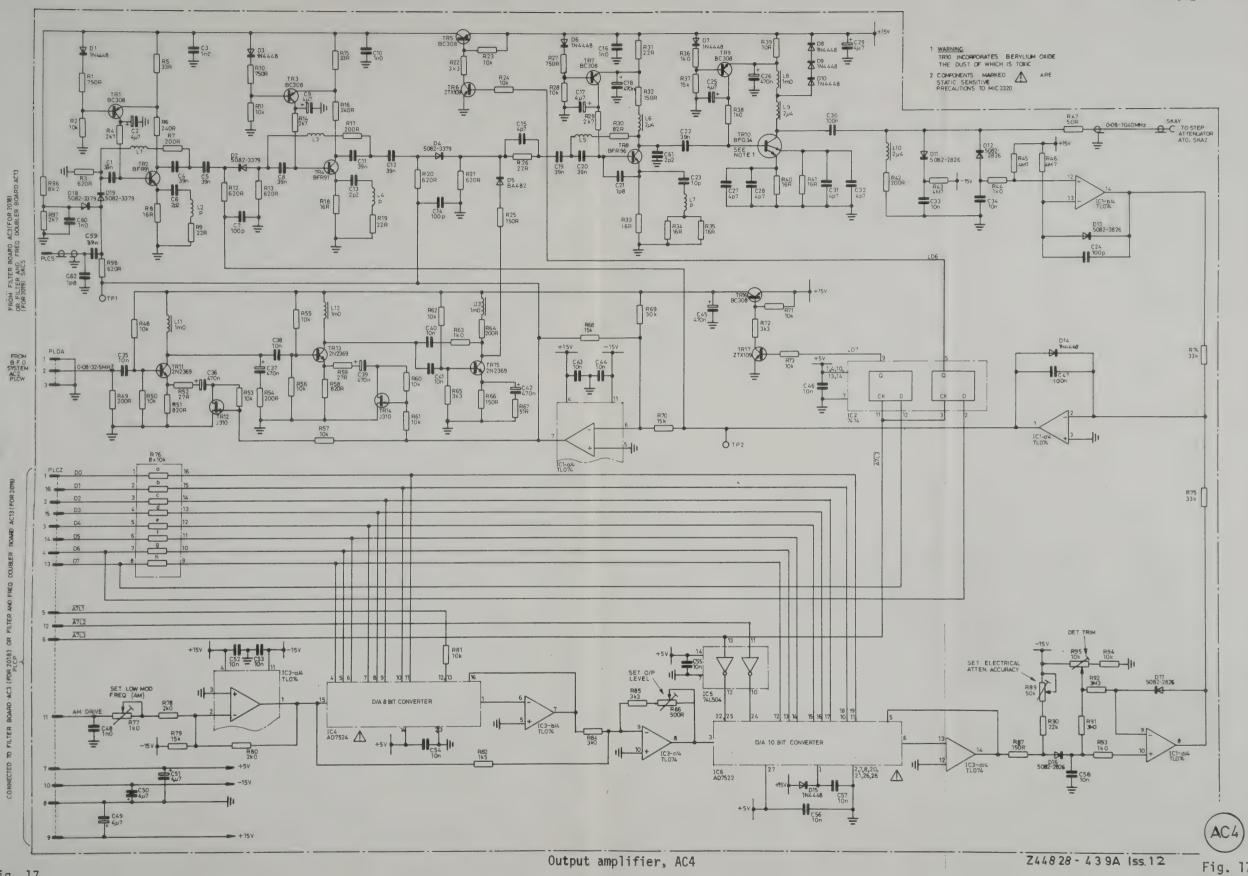


Fig. 17

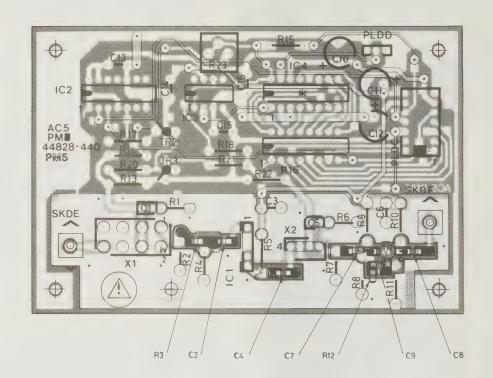
Fig. 17 Chap. 7 Page 35 Sep. 81

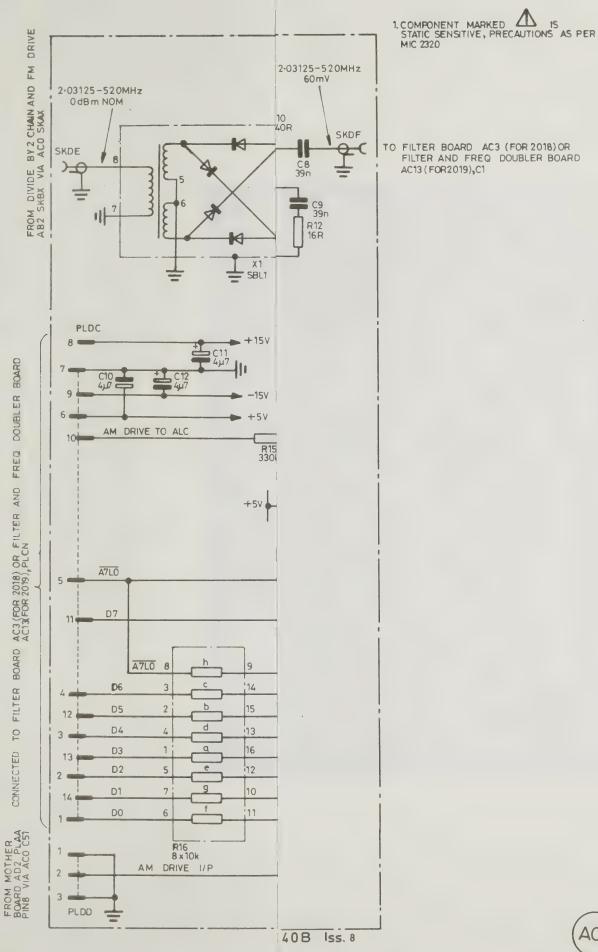




Sep. 81

Fig. 17 Chap. 7 Page 35

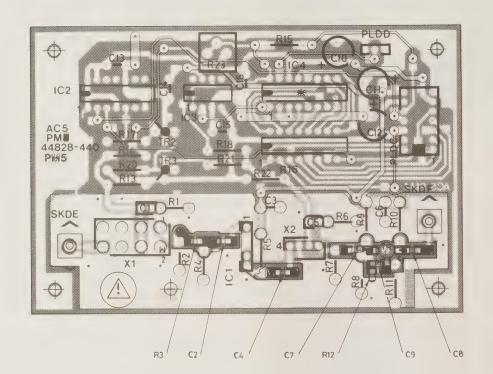




AC5

Fig. 18 Chap. 7 Page 37

Fig. 18



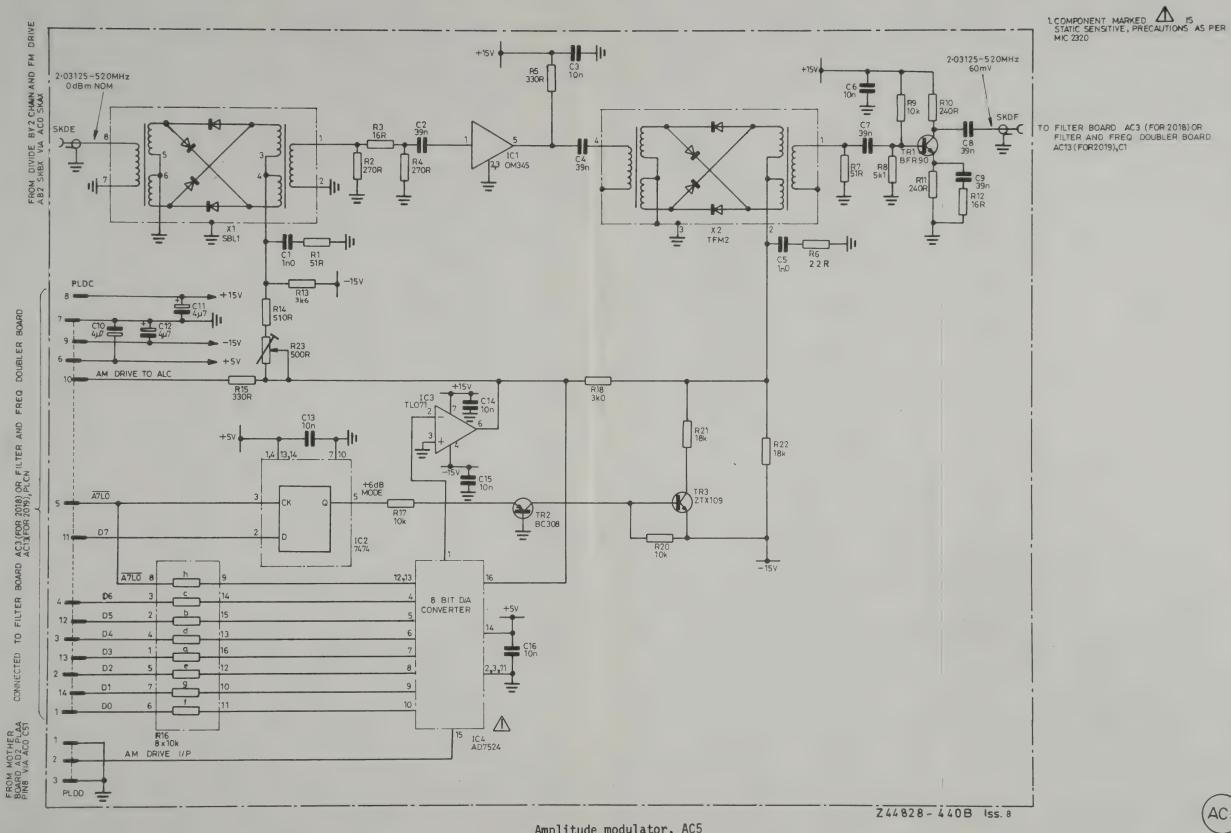
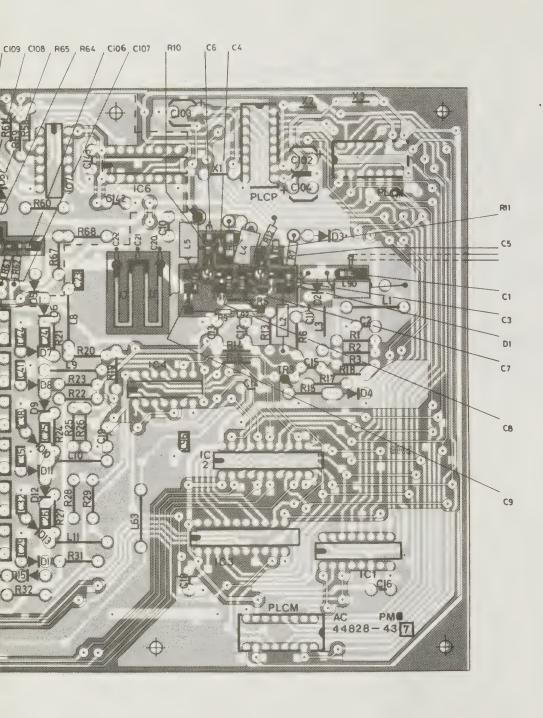


Fig. 18 Chap. 7 Page 37

AC5

Amplitude modulator, AC5

Fig. 18



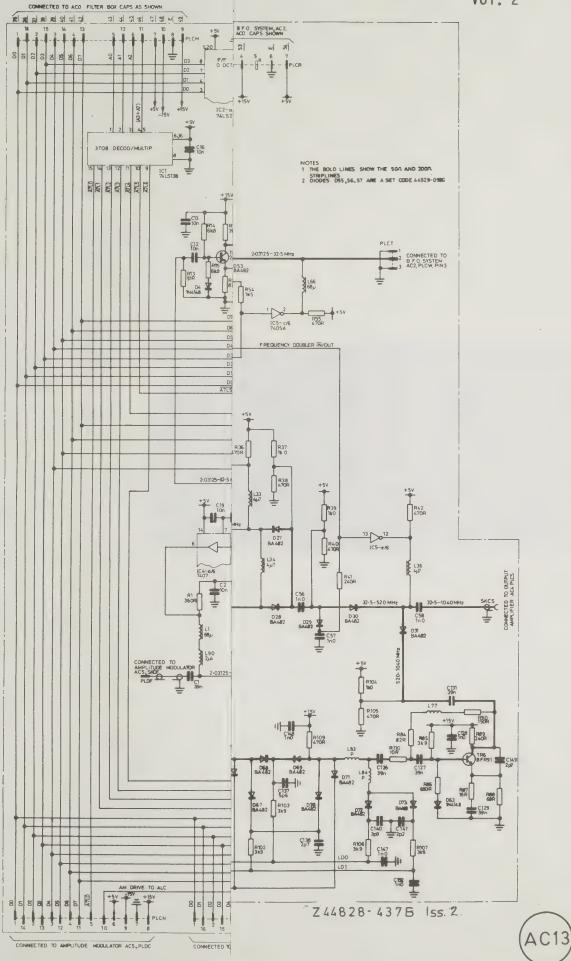
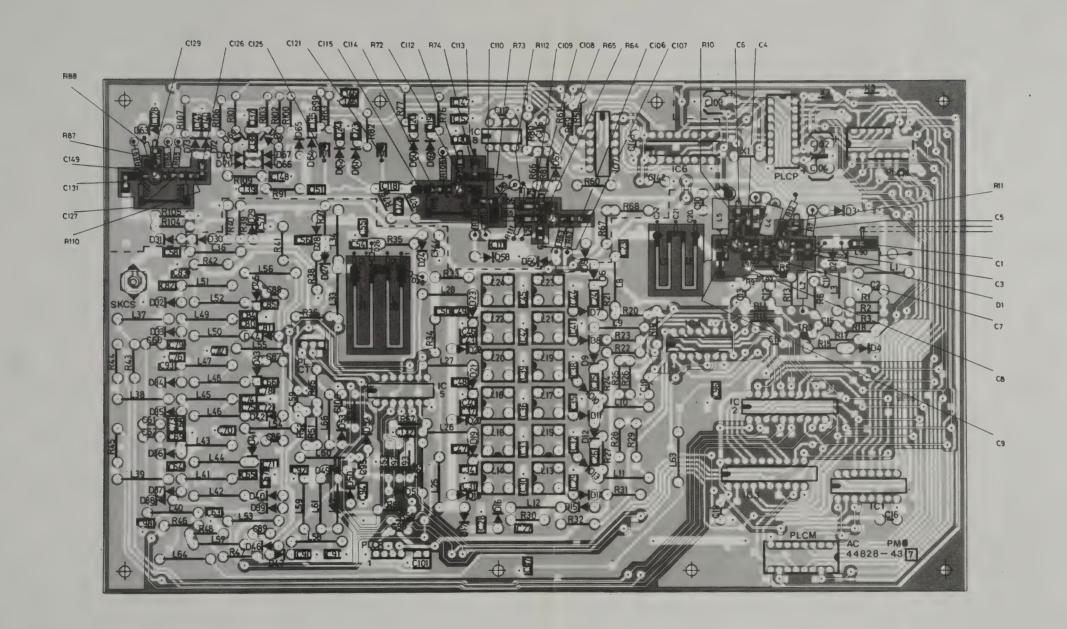
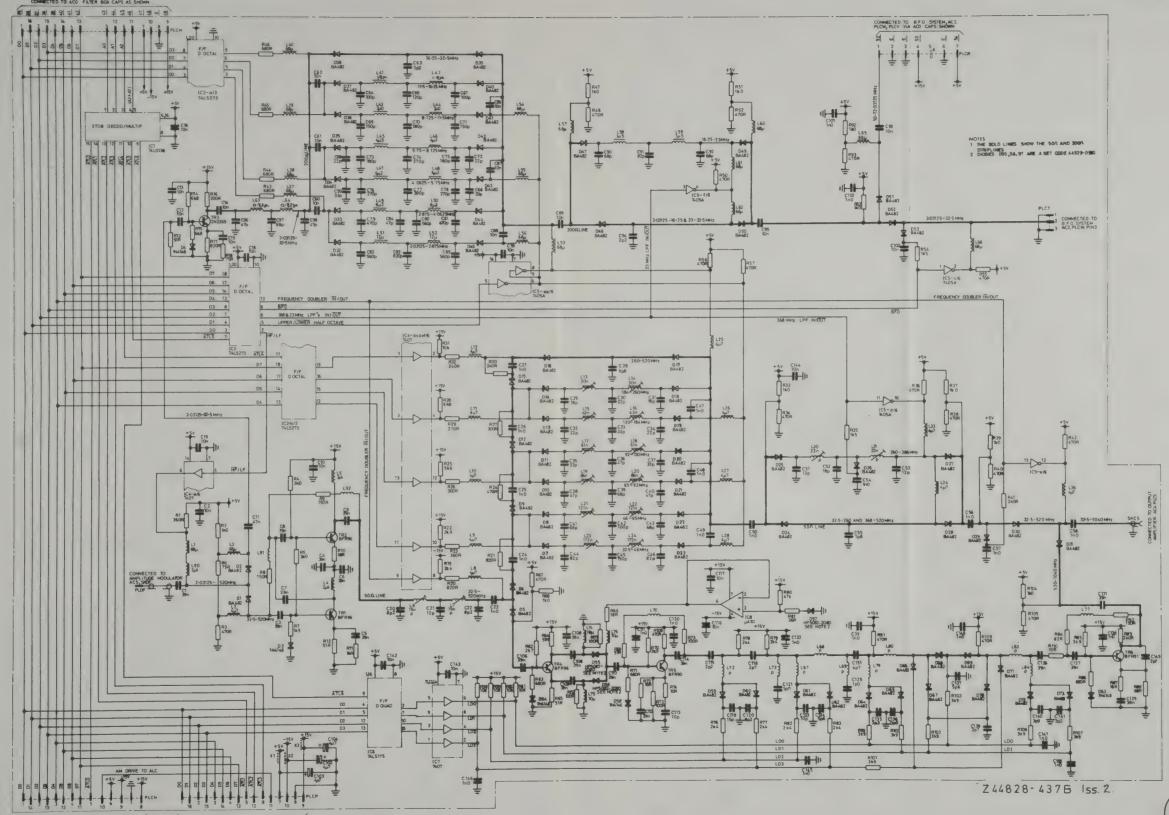


Fig. 19

Fig. 19 Chap. 7 Page 39



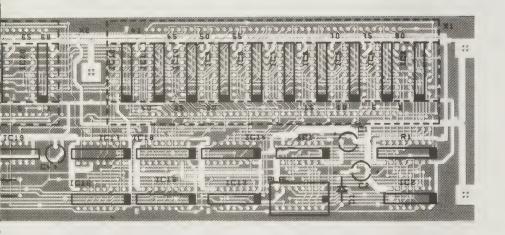


Filter and frequency doubler, AC13 (2019 only)

Fig. 19

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Fig. 19 Chap. 7 Page 39



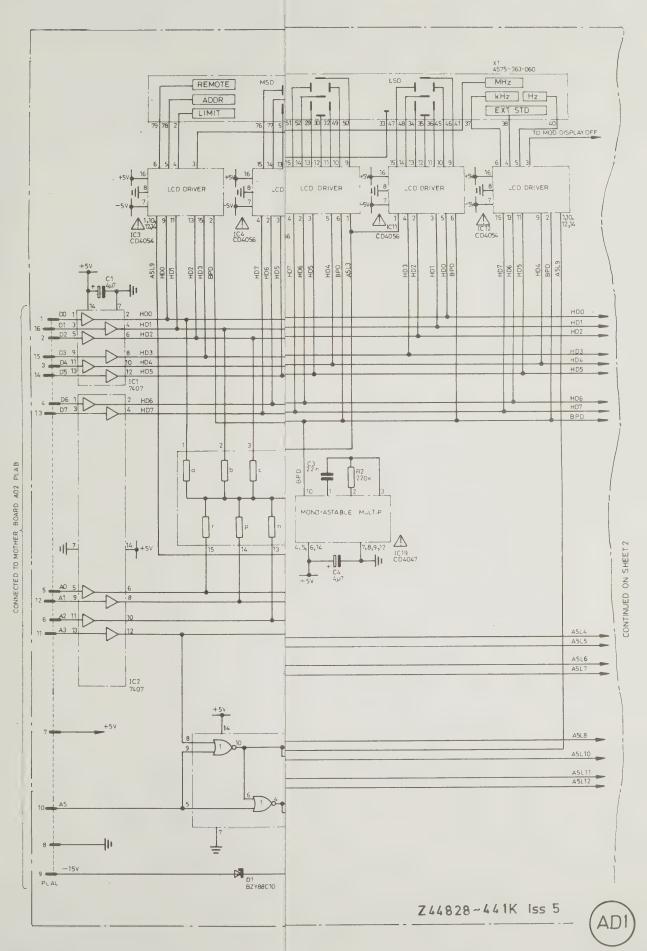
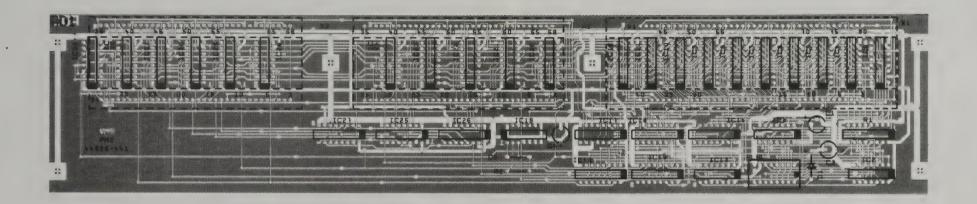
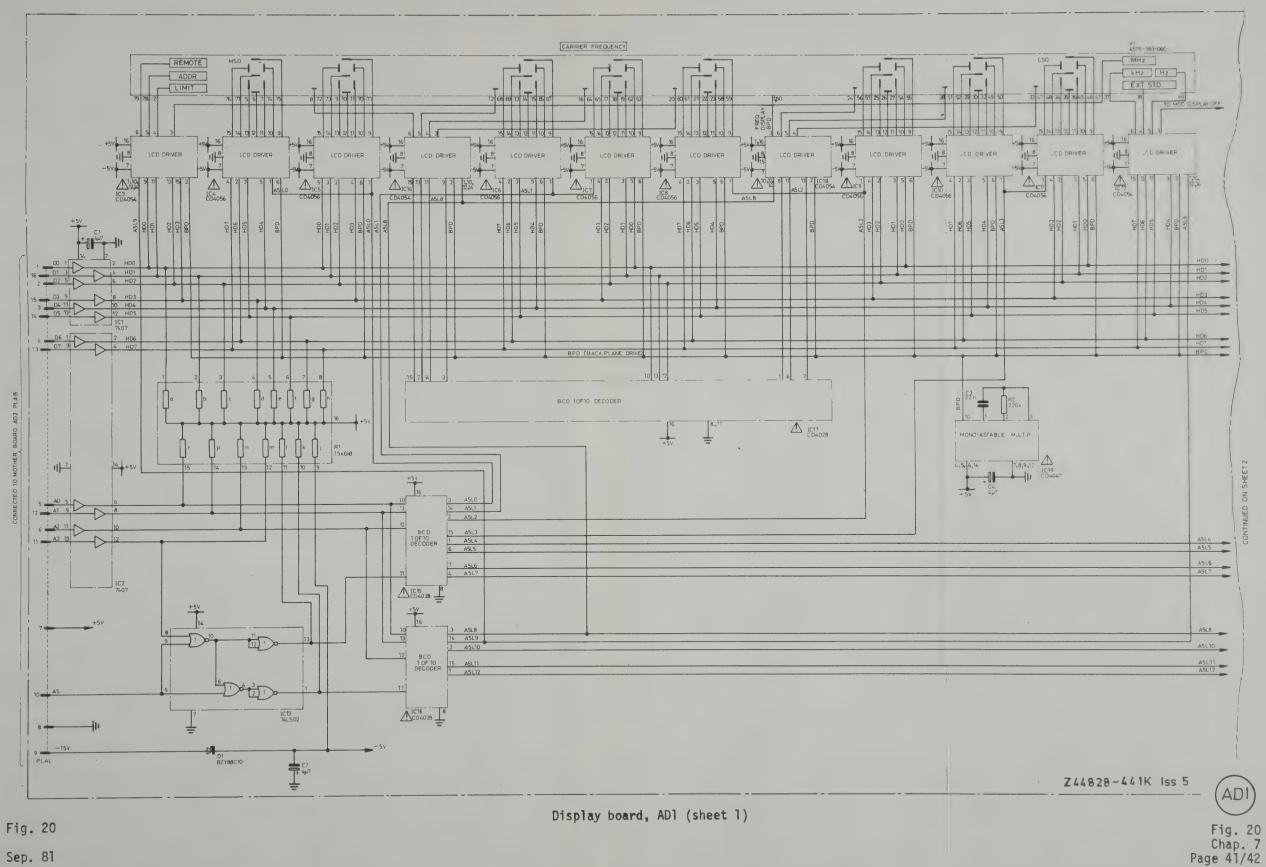


Fig. 20

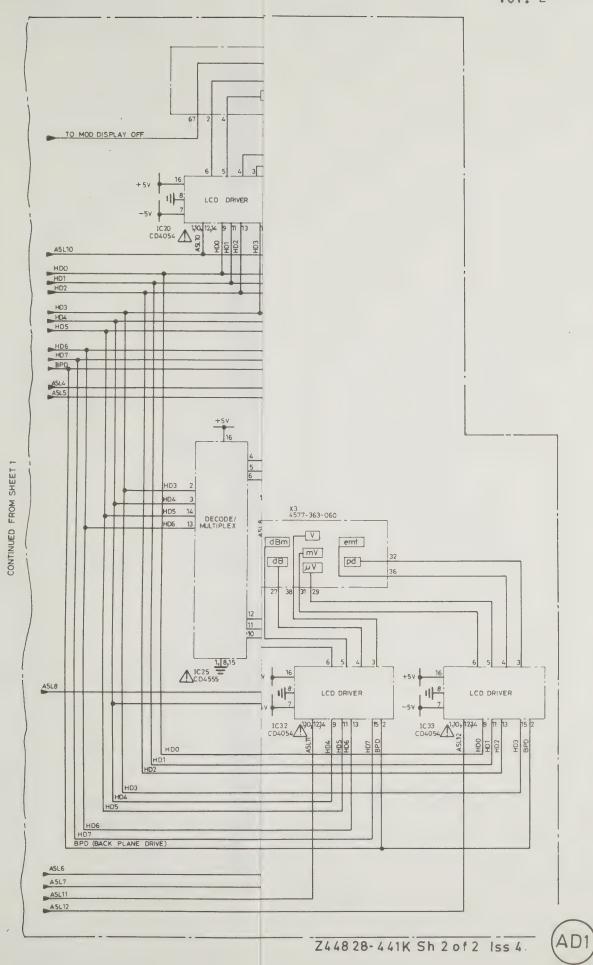
Fig. 20 Chap. 7 Page 41/42





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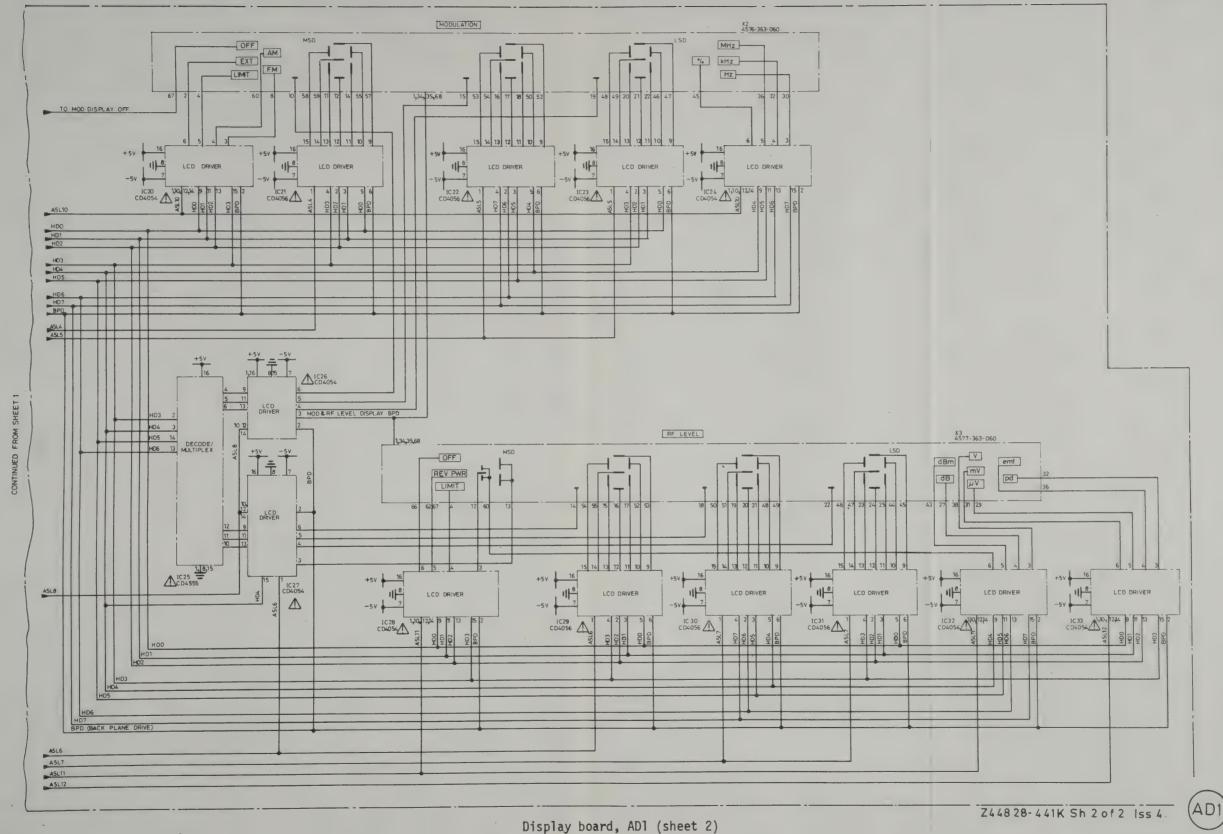




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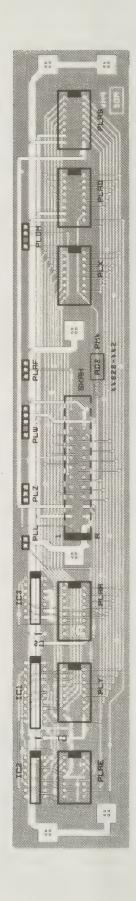
Fig. 21 Chap. 7 Page 43





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Fig. 21 Chap. 7 Page 43



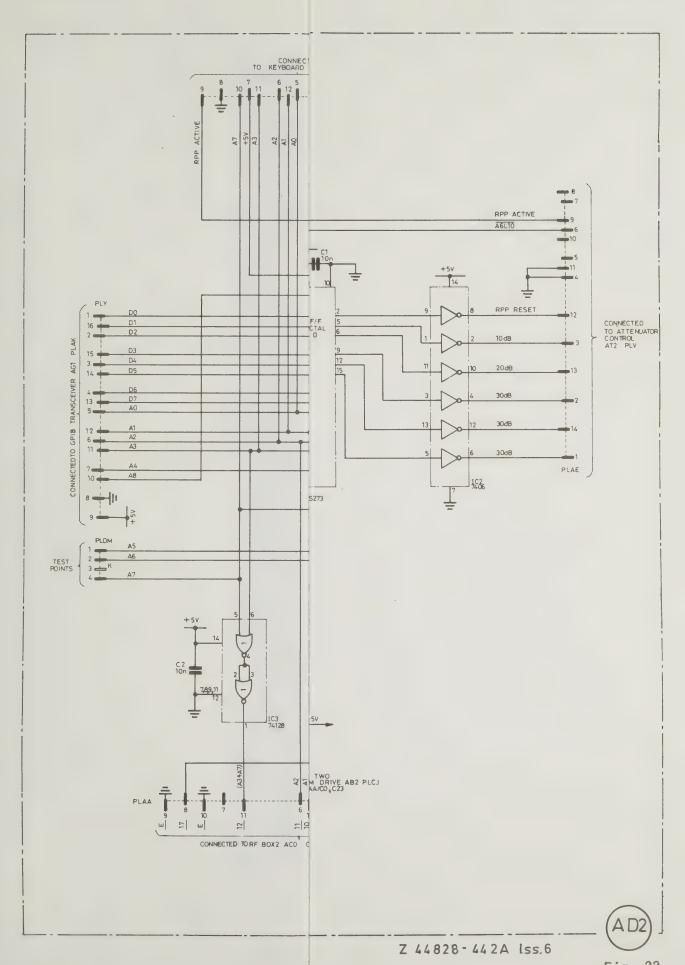
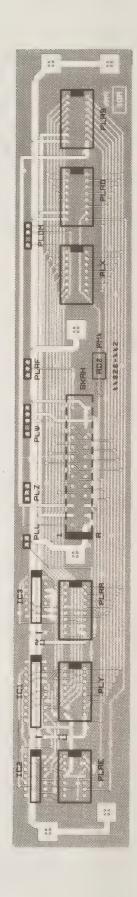
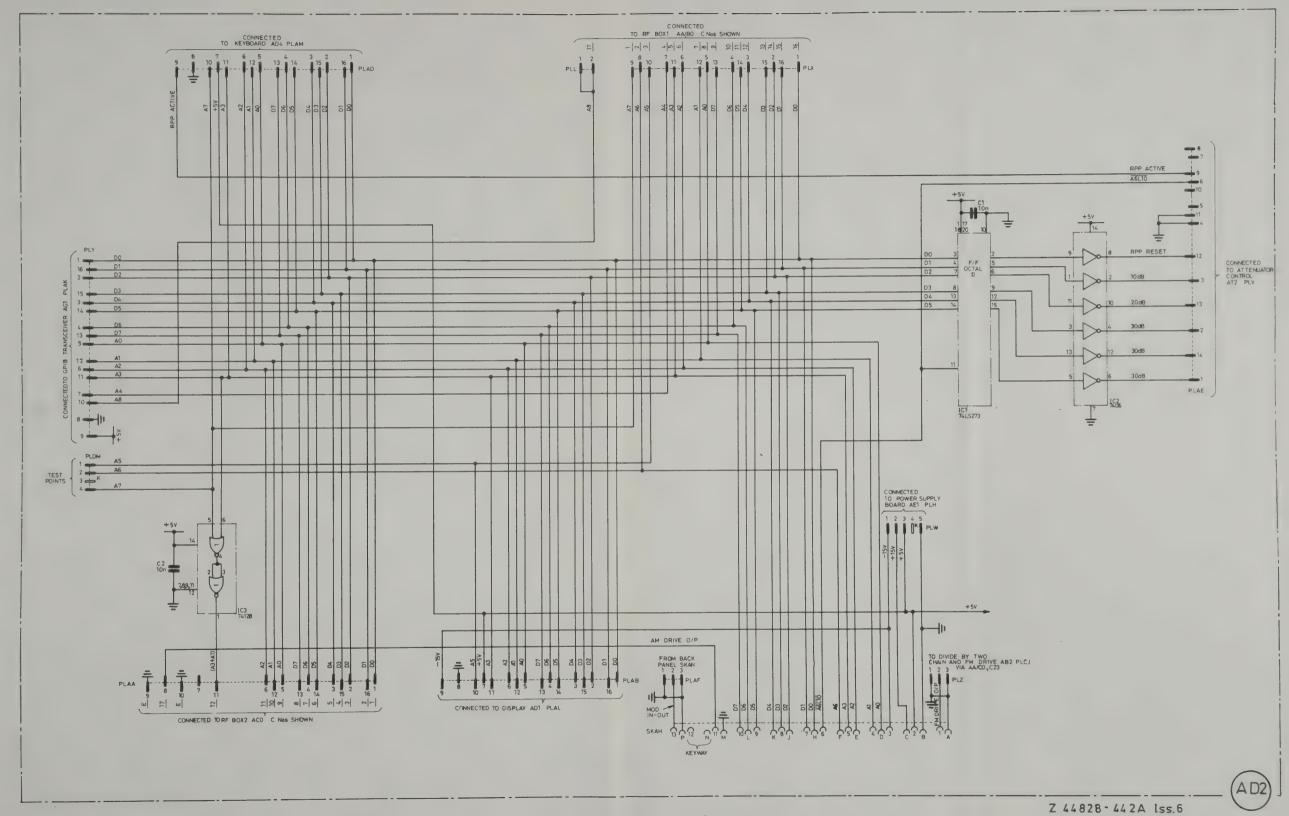


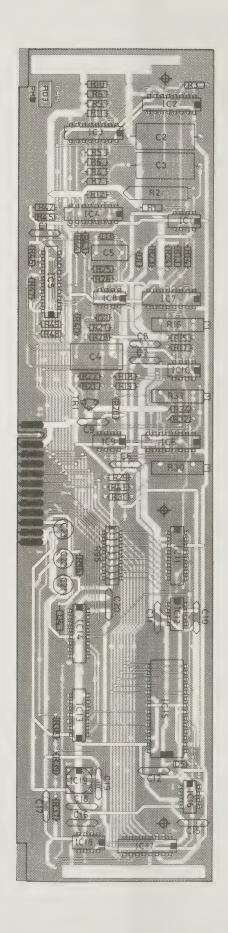
Fig. 22 Chap. 7 Page 45



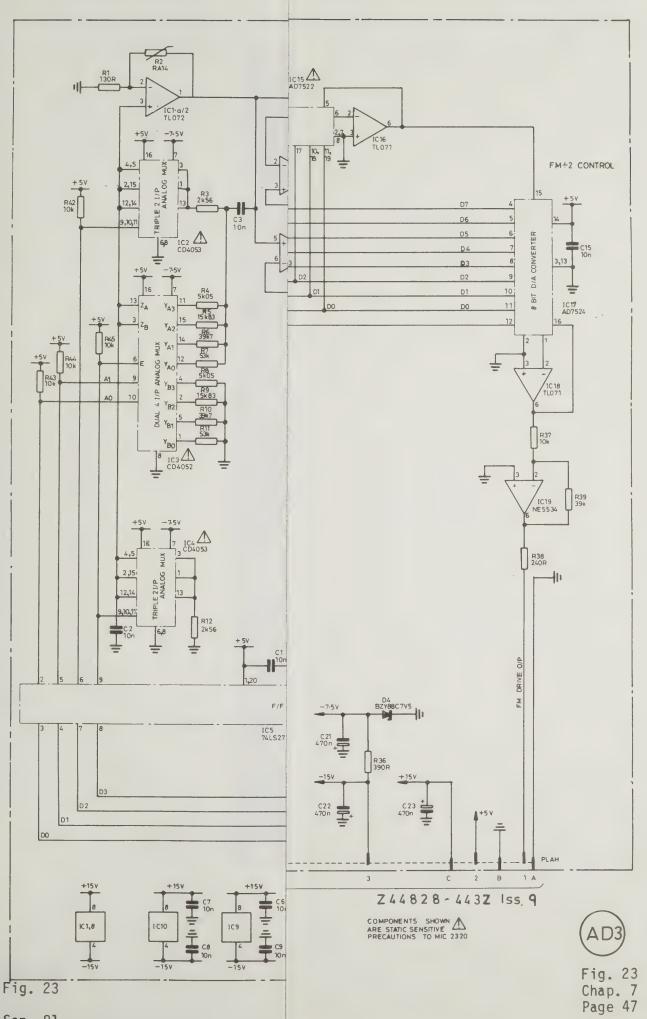


Motherboard, AD2

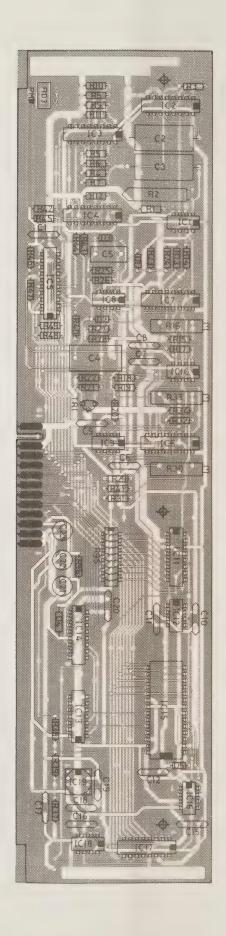
Fig. 22 Chap. 7 Page 45

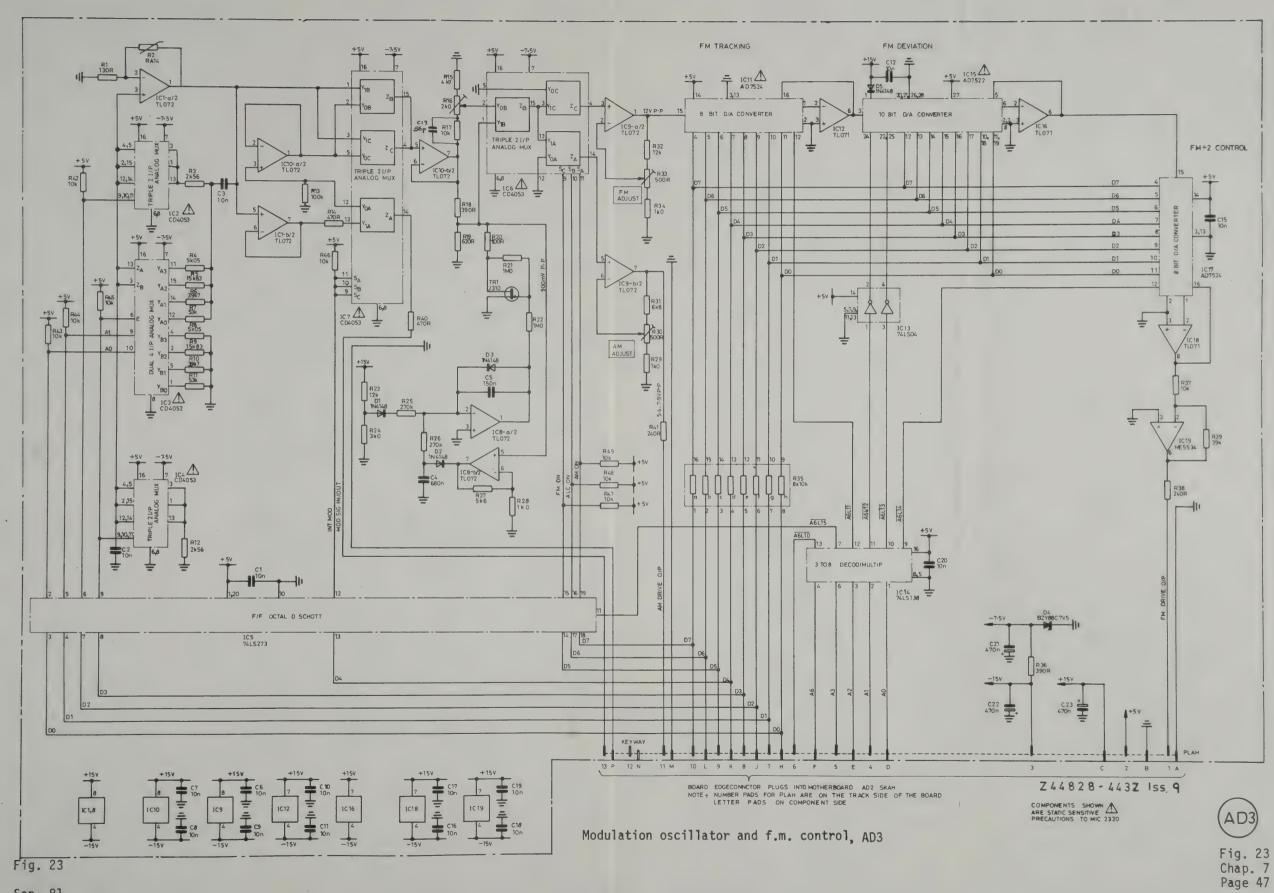


Component layout, AD3

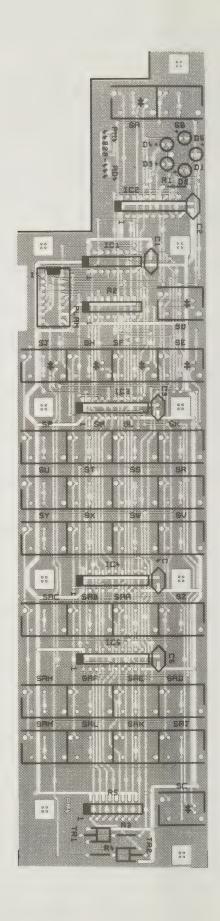


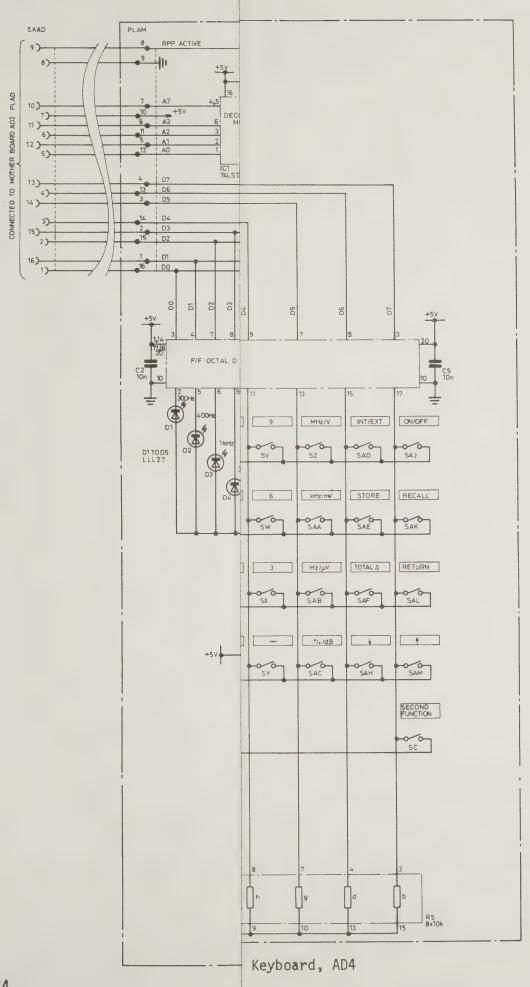
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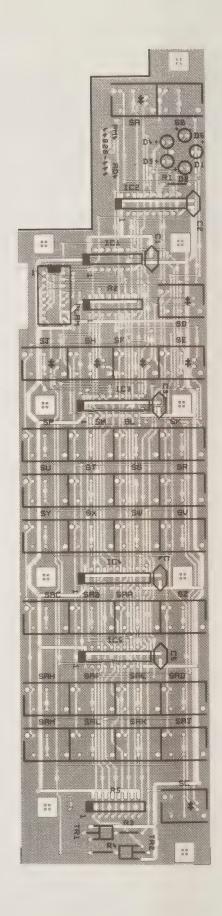
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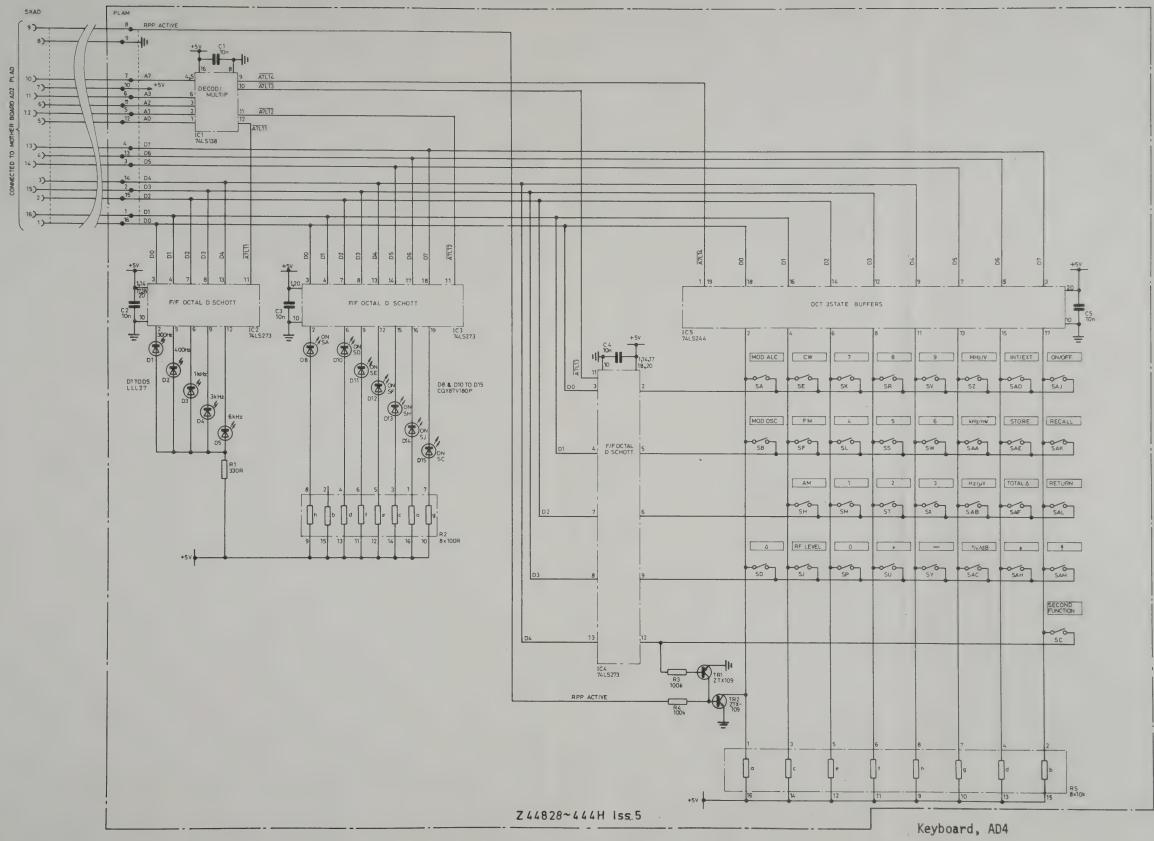




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Fig. 24 Chap. 7 Page 49/50



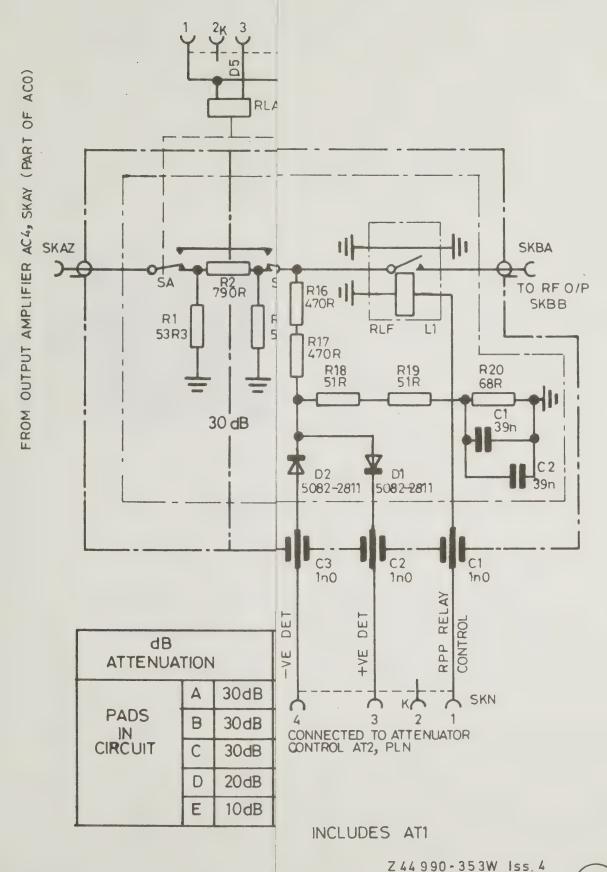


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Fig. 24 Chap. 7 Page 49/50

(AD4)



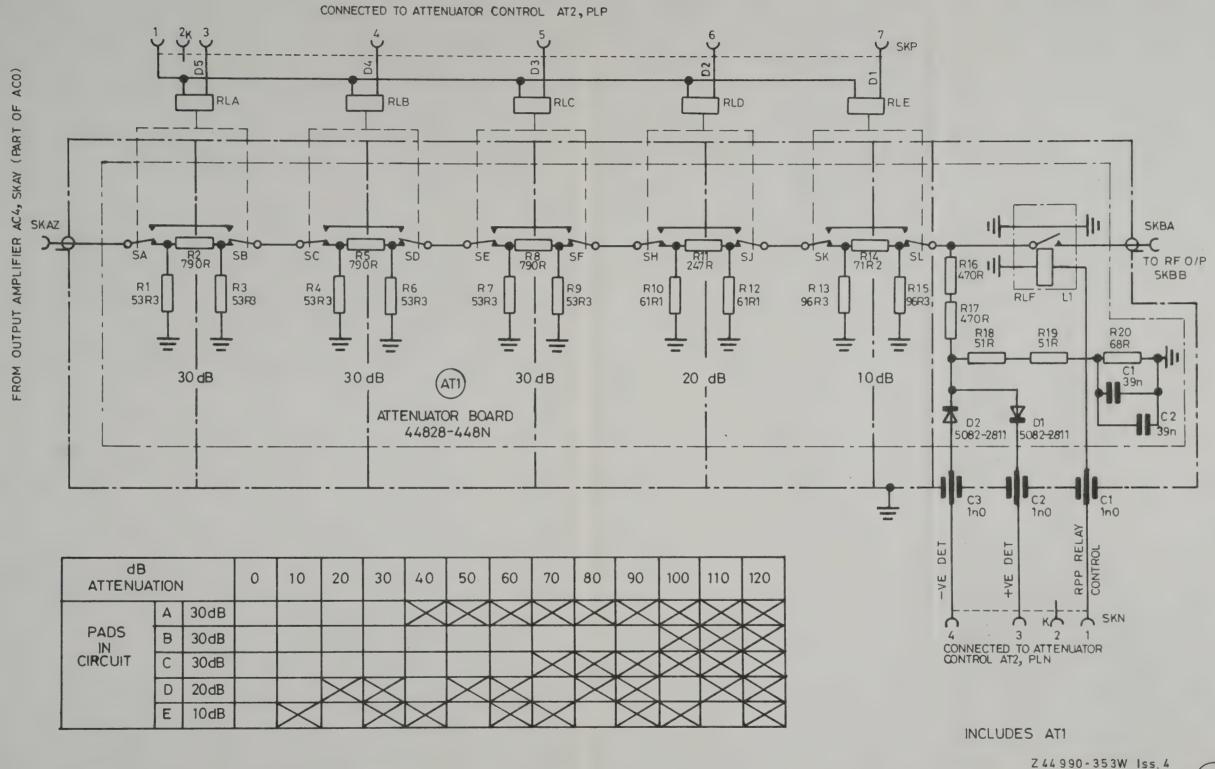


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(ATO)

Fig. 25 Chap. 7 Page 51

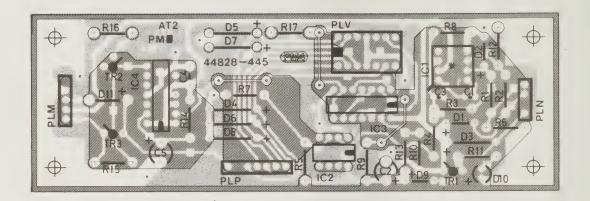




ATO

10 dB step attenuator, ATO

Fig. 25



1 COMPONENTS MARKED ARE STATIC SENSITIVE PRECAUTIONS AS MIC2320

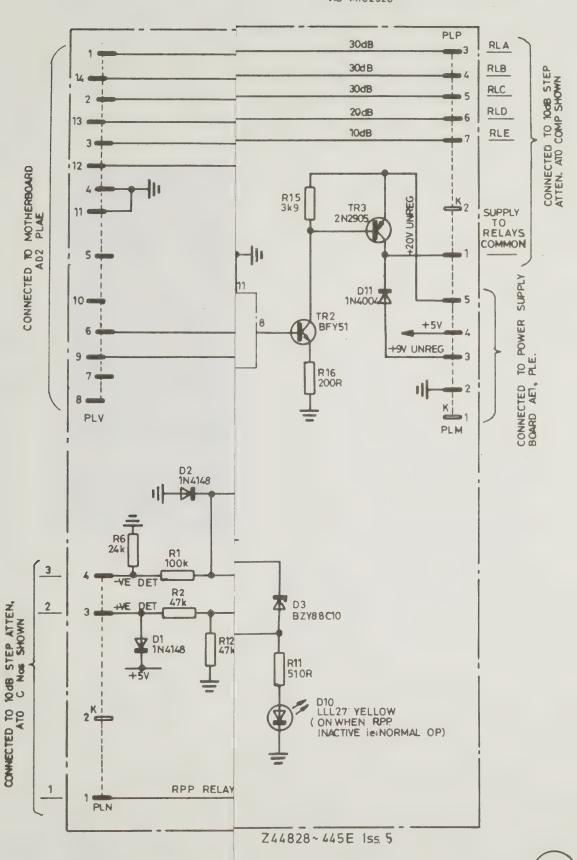
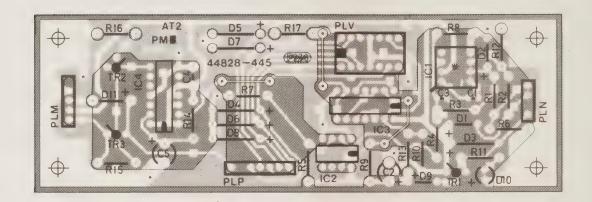


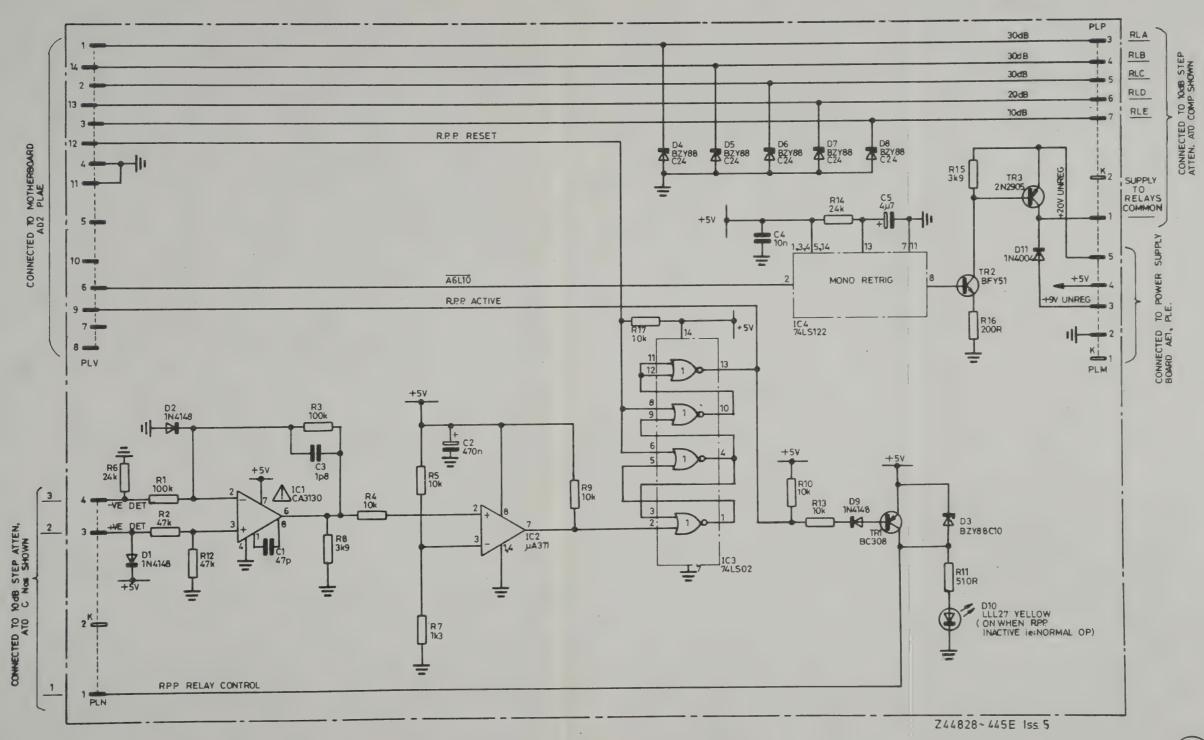
Fig. 26 Chap. 7 Page 53

AT2

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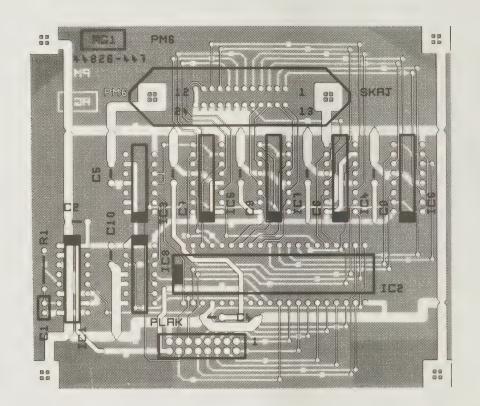
1 COMPONENTS MARKED ARE
STATIC SENSITIVE PRECAUTIONS
AS MIC2320

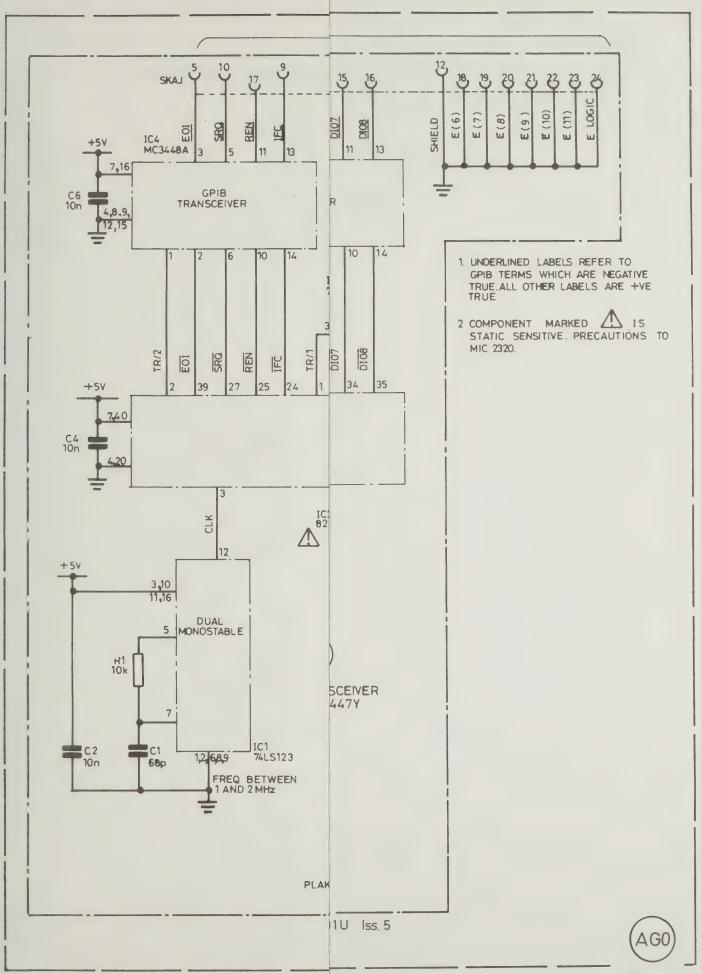


(AT2)

Fig. 26 Chap. 7 Page 53

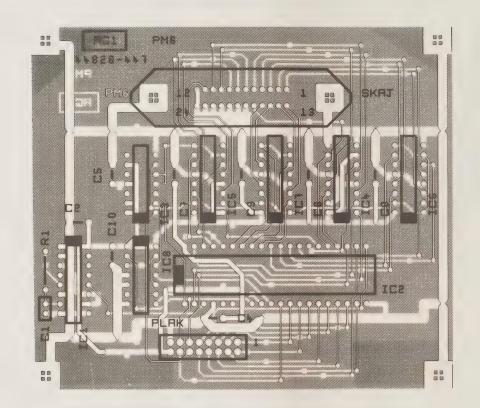
Attenuator control, AT2

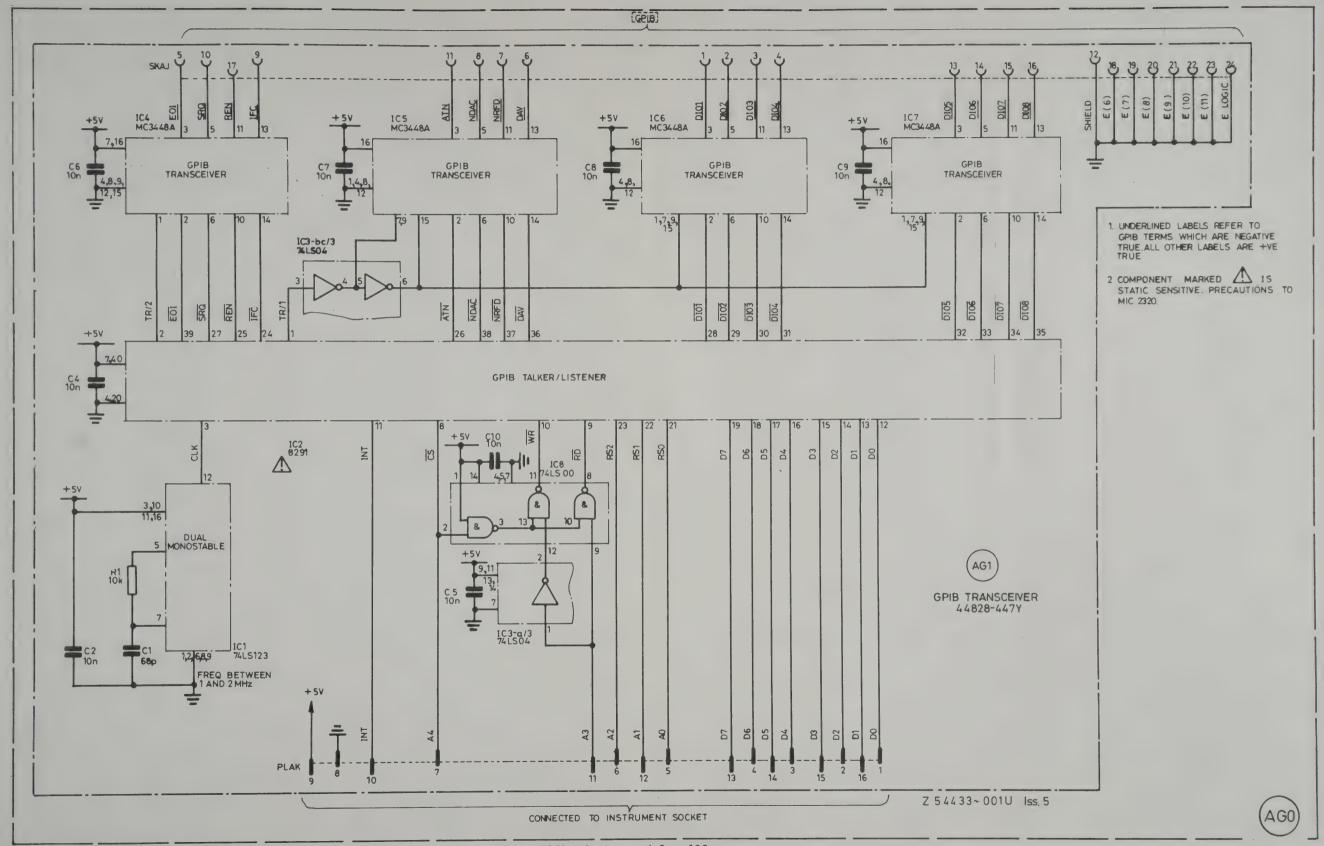




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Fig. 27 Chap. 7 Page 55/56





GPIB adapter module, AGO

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A GEC-Marconi Electronics Company



CANADIAN MARCONI COMPANY ELECTRONIC INSTRUMENTS DEPARTMENT

WARRANTY

Canadian Marconi Company (CMC) warrants each new Electronic Instrument sold by it to be free from defects in material and workmanship, and any Electronic Instrument which so proves defective within 12 months from date of delivery shall be repaired or replaced by CMC free of charge to the original purchaser, PROVIDED:

- (a) that CMC receives prompt notice of defect and satisfactory proof thereof establishing that the said Electronic Instrument has been properly maintained and operated within the limits of rated capacity and was not subjected to abuses (CMC's decision in this last instance shall be final and without recourse);
- (b) that original purchaser returns the said defective Electronic Instrument to CMC, c/o Electronic Instruments Department, Montreal, Quebec, and assumes all expenses for the transportation (repaired or replaced Electronic Instruments will be returned to the original purchaser at CMC's expenses). Under no circumstances shall CMC be responsible for loss of use and/or for any direct, incidental and/or consequential damages.

The foregoing warranty is the only responsibility of CMC and is in lieu of all other warranties whether expressed or implied.

MODEL NO	SERIAL NO
INSPECTED BY	WARRANTY DATE

This Electronic Instrument was thoroughly inspected and performance tested prior to shipment; if received in damaged condition, please file a claim with the carrier and advise Canadian Marconi Company, Electronic Instruments Service Dept. of the damages.

The second second second second

If necessary to return unit for service, ship to:

CANADIAN MARCONI COMPANY,
ELECTRONIC INSTRUMENTS SERVICE DEPT.
320 Aberdare Road
Door 10
MONTREAL, QUEBEC.

TELEPHONE (514) 341-7630 Ext. 560

COMPAGNIE MARCONI CANADA SERVICE DES INSTRUMENTS ELECTRONIQUES

GARANTIE

Les instruments électroniques vendus par Compagnie Marconi Canada (CMC) sont garantis contre tout défaut de matériel ou de fabrication. Si de telles défectuosités surviennent dans les 12 mois après la date de livraison à l'acheteur initial, elles seront réparées ou l'instrument électronique remplacé par CMC, sans frais pour l'acheteur initial, POURVU QUE:

- (a) l'acheteur initial avise promptement CMC de la défectuosité et fournisse la preuve que ledit instrument électronique a été bien entretenu et utilisé aux seules fins auxquelles il est destiné, et non soumis à un usage abusif (dans ce dernier cas, la décision de CMC sera finale et sans recours);
- (b) l'acheteur initial retourne à ses frais l'instrument électronique défectueux à CMC a/s du service des instruments électroniques, Montréal, Québec, (ledit instrument électronique réparé ou remplacé en vertu de la présente garantie sera retourné à l'acheteur initial aux frais de CMC). En aucun temps CMC sera responsable pour la perte d'usage de l'instrument électronique et/ou pour tout dommage direct, indirect et/ou incident.

La présente garantie est la seule responsabilité de CMC et tient lieu de toute autre garantie formelle ou implicite.

NO DU MODELE

Flande toronto 23.03.82

NO DE SERIE

VERIFIE PAR DATE DE LA GARANTIE

Cet instrument électronique a été inspecté à fond et son fonctionnement vérifié avant la livraison; s'il est endommagé à la réception, faites une réclamation au transporteur et avisez immédiatement CMC, Service de Réparations des Instruments Electroniques, des dommages constatés.

S'il faut retourner l'instrument électronique pour réparation, faites le parvenir à:

COMPAGNIE MARCONI CANADA

SERVICE DE REPARATIONS DES INSTRUMENTS ELECTRONIQUES,

320, rue Aberdare,

Porte 10,

MONTREAL, QUEBEC

TELEPHONE (514) 341-7630 Poste 560























